cinefex
number 65
$8.50
Canada – $11.00

CINEFEX

... the journal of cinematic illusions

publisher
Don Shay

editor
Jody Duncan

associate editor
Estelle Shay

senior writers
Janine Pourroy
Mark Cotta Vaz

advertising director
Bill Lindsay

circulation manager
Margie Duncan

PRINTED IN USA

CINEFEX, 66 – June 1996. Published quarterly at P.O. Box 20027, Riverside, California 92516. Subscriptions (U.S.): four issues – $26; eight issues – $44; twelve issues – $60. Printed by Valley Printers, Inc., Riverside, California. Contents copyright © 1996 by Don Shay. All rights reserved. Reproduction in whole or in part without written permission is prohibited.

Heart and Soul 44

Producer Rafaella de Laurentiis had to wait five years for effects technology to catch up with the demands of her dream project. But with perseverance, director Rob Cohen and cutting-edge digital effects by Industrial Light & Magic, *Dragonheart* and its uniquely expressive talking dragon at last came wholly to life. *Article by Jody Duncan.*

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Director Jan De Bont realized that a dead-on depiction of tornadoes and the destruction they wreak was essential to *Twister*, his suspense thriller about daredevil storm-chasers. Enlisted to produce the integrated effects were physical effects supervisor John Frazier and the digital team at Industrial Light & Magic. *Article by Jonathan Luskin.*

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To bring *James and the Giant Peach*, the classic Roald Dahl children's story, to the screen through the medium of puppet animation, director Henry Selick orchestrated a massive, two-year stop-motion effort augmented with digital contributions by Sony Pictures Imageworks and Buena Vista Visual Effects. *Article by Mark Cotta Vaz.*

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COVER – Draco strikes a sly pose in *Dragonheart.*

Aftershocks
Return of the Worms

article by Estelle Shay

In 1990, when Universal Pictures released the low-budget horror film *Tremors* – about two ne'er-do-well cowboys pitted against giant subterranean lifeforms that threaten their tiny, isolated town – the response from critics and audiences alike was one of surprised delight. What caught their fancy was the film's engaging blend of fifties-style horror and contemporary characters, fortified with a strong dose of humor. Directed by Ron Underwood and scripted by the writing team of S. S. Wilson and Brent Maddock, the film did not generate huge grosses at the boxoffice, but quickly achieved near cult-classic status in the video market.

As a result, Universal expressed some interest, early on, in a sequel. "We didn't take it too seriously at first," recalled Wilson, "because we couldn't come up with any good ideas. We really didn't want to deliver the same thing over again; and it wasn't until some time later – in one of those literal bursts of inspiration – that I awoke in the middle of the night thinking, 'What if the worms fragment into little creatures?'" Working from that premise, Wilson and Maddock applied the same reverse logic they had used so artfully in the first film. "Normally, movie monsters are indestructible; and that's what's scary about them. However, what was scary about our monsters was that you couldn't figure out how they worked. Once you knew that the graboids traveled underground and hunted by picking up sound vibrations, they became less dangerous. But it only took one movie to realize that. So our idea for the new creatures was that they would hunt by infrared radiation instead of sound. We thought: 'That will be fun. Everybody will be going around trying not to make any noise, when that's the wrong thing to do.'"

With assurances that at least two *Tremors* stars – Fred Ward and Michael Gross – were available for a sequel, Wilson and Maddock wrote Aftershocks, resurrecting the characters of Earl Basset and Burt Gummer. The story picks up several years after the original, with the giant predatory worms resurfacing in a Mexican oil field. Earl – whose fortunes have plummeted despite his brief brush with fame – accepts a lucrative offer by oil company officials to destroy the graboids. Using remote-controlled miniature jeeps rigged with dynamite as bait, Earl and new recruit Grady Hoover (Christopher Gartin) hunt the worms. However, when they encounter one of the graboids with its belly ripped wide open – and three empty placental sacs hanging from its innards – a new enemy emerges for which the old rules no longer apply. Reinforcements are summoned – namely, survivalist and ammunitions expert Burt Gummer.

In Aftershocks – a video sequel to Tremors – a remote Mexican oil field comes under attack by monstrous killer graboids, reinforced by a brood of smaller, but equally deadly, offspring.

Script in hand, producer Nancy Roberts first approached Universal's features division on behalf of Stampede Entertainment – the production company she had founded with Wilson, Maddock and Underwood. Unable to gain a firm commitment, her efforts would continue for more than a year. "Nancy single-handedly kept the project alive during that time," declared Wilson. "She worked just as hard to make the sequel as she had to launch the original movie. She pursued it with the features division; and when they proved unwilling to commit, she pitched it to the television division where there was interest in developing it as a TV series. When that fell through, she went back to the video division – which had been our constant cheering section – and asked, 'Are you still interested, and can we agree on a budget?'"

In Aftershocks – a video sequel to Tremors – a remote Mexican oil field comes under attack by monstrous killer graboids, reinforced by a brood of smaller, but equally deadly, offspring.

The answer was 'yes' – but making the deal with the video division meant that the scope of the film had to be reduced substantially. "The video arena operates much the way independent films operated in the fifties when Roger Corman was big," Wilson observed. "Our budget suddenly went from $17 million to approximately $4 million; and everything had to be scaled way back." Reworking the script, the writers reconceived all of the action sequences and reduced the number of creature effects to the absolute minimum needed to tell the story. Tentative plans to shoot the film on location in Australia were scrapped in favor of a local site, with a mere twenty-seven days allotted for completion of principal photography.

In late 1994 – with Roberts and Stampede's Christopher deFaria serving as producers, Maddock and Underwood executive producing and Wilson at the helm in his first major directorial effort – the project was finally greenlighted, and an effects team assembled. Working in Stampede's favor were the loyalties engendered by the first picture – a modestly budgeted, no-frills, 'hands-on' effort that had relied heavily on ingenuity and a spirit of hardworking camaraderie. "People wanted to work on this show," Wilson marveled, "and that was a fundamental part of pulling it off. Department head after department head came on and agreed to very painful cuts in

The graboids and their shrieker young were designed and built by Amalgamated Dynamics.

their budgets. We joked about the fact that I was one of the few people on the team who hadn't won an Academy Award. I was surrounded by all these incredibly talented people who agreed to do this because they loved the first film and they liked the new script."

First on board were Tom Woodruff, Jr. and Alec Gillis, of Amalgamated Dynamics, who had only recently launched their company when they were hired to create the creature effects for the original movie. "*Tremors* was our first project, and a real labor of love with a great group of people," Woodruff recalled. "We had said that if ever there was a sequel – no matter what we were doing – we would make ourselves available." As luck would have it, principal photography for Aftershocks would coincide with location shooting for Jumanji – the biggest project in the company's eight-year history. Determined to keep their promise, Woodruff and Gillis signed on anyway, placing shop foreman Andy Schoneberg in charge of the Aftershocks creature construction while they supervised the work long-distance from Vancouver.

With a modest budget and just six weeks in which to complete all of the creatures needed for the live-action shoot, ADI set to work building the giant dead graboid discovered early in the film. The full-size, thirty-foot-long worm husk was constructed as a wood and wire armature, with poly-foam skins cast by Marc Tyler out of molds used for the worms in the original production. Tyler then painted the creature, dusted it down and dressed the inside to reveal three distinct chambers with torn placental sacs.

For an earlier scene, in which Earl and Grady encounter the graboid alive, but in the throes of giving birth, a quarter-scale version was built by Schoneberg and Steve Frakes, again using molds resurrected from the original movie. "This time," said Woodruff, "instead of foam latex, we had the advantage of a new hot-melt material we had used in The Santa Clause." The substance, developed and distributed by Fiber-Resin Corporation, proved particularly effective for an early shot of the worm writhing in agony, filmed at 96 frames per second on a miniature tabletop set with a puppeteer operating the construct from below. "It was so jiggly and lifelike, we were able to get some really good blubbery movements to show something we really hadn't seen in the worms yet – the conveyance of great mass and weight."

Concurrent with construction of the graboids was the design of their 'shrieker' offspring, which would consume considerably more screen time than their progenitors. Locking in a design for the shriekers would prove more elusive than it had been for the giant worms. "The shrieker designs went through a number of variations before we finally hit on the right look," noted Wilson. "Partly it was a size thing, and partly it was the fact that these creatures are supposed to be babies – something Tom and Alec and Andy Schoneberg worried about right from the start. There's an inherent cuteness to babies – but we knew the shriekers had to be scary; otherwise audiences might start feeling more sympathetic toward the monsters than the humans."

From Vancouver, Gillis and Woodruff began faxing shrieker sketches back and forth to the production. "We knew that they wanted two-legged little creatures that ran around, saw by infrared and emitted a scream upon sensing a source of food," Gillis recalled. "One of the features of the original movie's creatures was the big four-piece head, jaw and mandible assembly; and we wanted to maintain that." Treading the delicate line between cute and terrifying, a concept was developed that juxtaposed a pot-bellied, squat body – suggesting the babyish aspect of the creature – with the

eyeless, grotesque head characteristic of the adult worm. Two muscular ostrich-like legs, balanced by large three-toed feet and a flat tail, completed the overall look.

ADI puppeteers operate one of two animatronic shriekers constructed for the film.

Key to the design philosophy was the intent to portray the creatures in biologically plausible terms. "What we liked about *Tremors* was that there was a logic to it," Gillis remarked. "So Tom and I actually wrote up several pages of backstory on the shriekers, offering different scenarios of how they reproduce, how they communicate – that sort of thing. For example, we decided that they are pack animals; and the purpose of the food scream for a creature that can neither hear nor see is to raise its body temperature, thereby attracting its pack. That provided the rationale for incorporating several brightly colored spots – one on the jowls and one on the side of the tail. We reasoned that those spots, in particular, would heat up during a food scream and work as a heat signature, totally unique to the shrieker. The pack members would recognize it – and that would prevent them from mistakenly attacking each other."

Three others were conceived as modified hand puppets.

An aspect of the design that proved especially vexing was the heat-seeking organ that periodically extends from the top of the creature's head as a means of tracking food via infrared. "We tried panels that lifted up from the head like gull-wing doors to reveal the sensory organ inside," Gillis recalled, "but Steve was concerned that those might look like ears. He wanted something totally non-anthropomorphic. Then we toyed with the idea of a plate on top of the head that lifts up; but we were afraid that would look too much like a trap door – something you'd expect to see Thing from The Addams Family pop out of. Finally, Andy came up with a three-plate design that was more organic looking."

Once designs were approved, ADI began construction on the full-scale shrieker puppets – two fully-articulated, cable-actuated hero versions and three hand puppets with floppy legs and fully-articulated heads and bodies. Additionally, five nonarticulated floppy bodies – essentially stunt dummies – were built for scenes of shriekers being blasted by Burt's elephant guns. Three articulated tongues were created for insert shots.

Working from a ten-inch-tall clay maquette – designed by Gillis and Woodruff and sculpted by Gillis – the full-size puppet figures were sculpted by Schoneberg, Jim Kagel and Brent Armstrong. Mark Viniello cast the skins in foam latex, while Steve Frakes crafted the skull pieces from fragile translucent fiberglass. "Translucency was important to us," said Gillis, "because we wanted the skulls to look somewhat cartilaginous, implying that these creatures are not yet fully formed."

Mechanics, designed and constructed by Dave Penikas, provided the complex head articulation, including jaw and mandible movements. Multiple bladders inside the heat-seeking organ provided a pulsating effect when the organ was exposed. To operate the hand puppets, a puppeteer positioned in the body gripped interior handholds and maneuvered controls by means of a backpack connected to four-way jaw and neck mechanisms. A small peephole at the creature's throat allowed the puppeteer to see.

On set, the shrieker puppets were dressed by Yuri Everson to match their environment "To make them look as if they belonged in the environment," related Gillis, "buckets full of dirt were rubbed all over the bodies and applied to areas in the corners of the mouth where the bony shapes meet. Then we squirted water in the creases behind the neck and dusted the high points so that it looked like oily sweat where the folds were contacting. We also spritzed the colored areas on the jowls and tail so that the color spots would appear shiny – as if there were extra body oils in them because they heat up."

Fourteen crucial shots of shriekers running and climbing on one another were achieved via computer animation at Tippett Studio.

For a scene in which a caged shrieker spontaneously reproduces by disgorging its offspring, a mucous ball – dubbed 'the vomit baby' – was sculpted from foam by Marc Tyler and painted by Tom Killeen. During filming, the fetus – covered in a slimy membrane – was pushed out the mouth of a full-scale shrieker puppet, adapted with jaws capable of hyperextending. A subsequent shot showing the tiny newborn breaking out of its placental sac was accomplished using one of the full-scale mechanical shriekers, puppeteered by Yancy Calzada and shot on an oversized section of cage built by production designer and *Tremors* veteran Ivo Cristante.

Fourteen crucial shots of shriekers running and climbing on one another were achieved via computer animation at Tippett Studio.

Although most of the shrieker effects would be accomplished with the ADI puppets, Wilson had known from the start that some form of animation would also be needed for shots of the creatures running and climbing. Toward that end, Wilson had persuaded stop-motion veteran Phil Tippett to do some early testing while the sequel was still in development. "The process of getting Aftershocks approved took so long," commented Wilson, "that on my first visit to Phil's studio, just after he had concluded work on *Jurassic Park*, it was still filled

with old Mitchell cameras and grip stands and all sorts of hardware – a kind of wonderful alchemy. Phil shuffled over to a door, opened it, and said, 'Well, I have one computer in this back room.' The next time I went – about a year later – I walked into the same space, and we laughed because the change was so startling. Everything had been cleared away and replaced with little cubicles and computer workstations."

The Aftershocks assignment – consisting of fourteen shots – was to be one of Tippett Studio's first independent efforts in computer animation. "Our goal on Aftershocks was really to generate a great deal of animation as quickly as possible," noted Tippett. "At the time, we were just beginning to make the transition to digital; so it was an ideal opportunity to take some of the input device work we developed on *Jurassic Park* a bit further, to get in there and start experimenting with other ways of puppeteering and moving characters around. Since the film would be going straight to video, we knew we could work in broad strokes and concentrate on refining some of our techniques."

Tippett commenced by providing input into ADI's shrieker designs, identifying potential problem areas for the digital versions. "Once we had some idea of what Tom and Alec were going to do," stated Tippett, "we could make a few suggestions – such as how to fit certain body parts together or where to put the wrinkles in the skin – things that would make our work easier."

Tippett Studio art director Craig Hayes supervised construction of the digital characters. "We began by scanning photographs of ADI's shrieker maquette into our computer and tracing over it," said Hayes. "As soon as ADI completed one of the full-scale puppets, they sent it to us for reference and we took our measurements from that." A three-dimensional model was built by Peter Konig, then painted and texture mapped by Paula Lucchesi to match the ADI puppets. Reference photos taken on location enabled the digital artists to duplicate precisely the look of the puppets, down to the dust and dirt used to dress them on the set.

Animation was accomplished with a range of techniques. "Anywhere from one-third to two-thirds of the animation was done through stop-motion input," related Hayes, "using a shrieker armature built by Bart Trickel and our own motion input software. It was very similar to the methods we used on *Jurassic Park*."

For shots of Earl moving through a warehouse filled with shriekers, digital artists duplicated the computer model to make it appear as if there were dozens of creatures in the scene, then animated each one individually. "Any time you get more than one character on the screen, it really complicates the animation," said Tippett. "They have to interact, and the pantomime has to be staged in a way that makes the action clear. We basically built a room full of characters, then animated them individually so they wouldn't all appear to be moving at exactly the same time. When you're dealing with a bunch of things, the whole mass takes on a character of its own. You're really animating an overall texture. Otherwise, the shot can turn into a can of worms, with audiences not knowing what to focus on." The computer generated images were composited at Tippett Studio into live-action backgrounds, shot on location with a locked-off camera.

ADI crew members puppeteer a graboid that has burst forth from its subterranean domain.

In January 1995, Wilson assembled his cast and crew in Valencia, on pasture land leased from Newhall Land and Cattle, to commence filming. The schedule was daunting: a mere twenty-seven days in which to complete the location shoot, less than half the time it had taken to do Tremors. Existing buildings at the site were redressed, and new structures erected to depict the small Mexican outpost. "It was the greenest the land had been in twenty-five years,"

noted Wilson, “which was a problem because the worms are supposed to be desert creatures. So we revamped the beginning of the script and said: ‘Okay, they don’t live in the desert. This is the Mexican variety of the creature, and it lives in southern Mexico on verdant plains.’“

For an opening attack scene and subsequent shots of the worms being destroyed by explosives, Wilson turned to physical effects supervisor Peter Chesney, who doubled as second unit director. Having just come off Waterworld, Chesney found himself transitioning overnight from one of Hollywood’s biggest-budget productions to one of its smallest. “In really big pictures, you tend to lose a sense of filmmaking because they become corporate or management driven,” remarked Chesney. “Then you go to a small film – where there’s great camaraderie and you’re working with people you know, who have become your friends – and it rekindles your interest in filmmaking.”

Chesney’s initial task was to devise a rig that would launch the subterranean worms up through the ground. “The underground rigs we used in *Tremors* were powered by air rams,” stated Wilson, “which often jammed and never really moved the worms fast enough. I told Peter early on that one of the things we desperately needed was to see a worm come out of the ground and lift someone in the air.” Chesney’s above-ground solution proved highly effective. Ivo Cristante’s team provided an eighteen-foot-tall, twenty-foot-square platform to house the launch rig – an uneven parallelogram crane to which a mechanical puppet was mounted. A spring-loaded device was used to bring the worm up to speed. “We built a nine-foot-wide steel track with skateboard-like guide wheels,” said Chesney, “and added a lot of counterweight on cables to power it, including a huge amount of bungee cord. We actually had to use a block and tackle to pull it down, like loading a catapult.”

A breakaway ground surface completed the effect. “We were trying to duplicate the energies of an eight-ton creature with the ability to plow through brick walls,” observed Chesney, “but the puppet had to be light enough to perform properly – which meant it wouldn’t have the strength for a big breakaway. So we prepared the platform surface by layering hinged pieces of plywood in jagged sections, laid out like the scales of a fish. At the intersections we used small sticks – and even finer sticks in the crosshatch. On top of that, we laid peat moss and sod.”

For shots suggesting the worms’ movements underground, Chesney replicated a technique used successfully in Tremors. A wood-lined trench was dug, then covered with a stretchy neoprene rubber and laid down with successive layers of dried peat moss and sand from the natural environment. A torpedo-shaped boat buoy, lubricated with baby powder to prevent its snagging the rubber lining, was then towed along in the trench by a four-wheel-drive all-terrain vehicle.

Chesney was also tasked with creating on-set explosions for early scenes of the graboids under assault, as well as a final massive blast in which Burt’s arsenal of explosives obliterates a food warehouse overrun with shriekers. “Fortunately, we were in a good location for staging practical explosions,” observed Chesney. “We were out in a cow field, away from buildings and expensive property, and the ground was very compacted and free of rock. That gave us the freedom to use some heavy-duty explosives.”

The final climactic scene had been scaled way back from the original concept, which featured thousands of swarming shriekers. Wilson resisted cutting back on the explosion itself, however, and insisted on a blast of gargantuan proportions, with a realistic concussion wave. “The only thing left of my big ending was the explosion,” recalled Wilson, “so it was really important that it be

convincing. I wanted there to be no question in the audience's mind that the creatures are utterly destroyed."

To stage the blast, Chesney placed a quarter-scale model of the warehouse on a plywood platform two to three feet off the ground, and rigged it with nearly a thousand pounds of debris. Twelve pounds of commercial explosives were implanted to guarantee thorough decimation. Fuller's earth was dusted on surrounding grass to ensure that a layer of dust would be seen rising as the concussive wave hit. Recording the blast was a Photosonics camera shooting at 360 frames per second.

The explosion was so powerful that an outlying building was knocked down by the Shockwave. "We actually ended up with a crater where the miniature had been," recalled Wilson. "The platform was completely disintegrated, and the grass flattened for twenty or thirty feet." A final view of a massive crater was achieved via a matte painting. "Rocco Gioffre did a classic in-camera matte painting, done the old-style way, on undeveloped negative that went through the camera on location."

In an age of big-budget movie-making and extravagant effects, Aftershocks – like its predecessor – was a throwback to a long gone era. "This was down-and-dirty low-budget filmmaking at its best," Wilson reflected. "I know people have made movies in less time, but rarely one as complex as this. What made it a delight was the tremendous support, inventiveness and professionalism on the part of everyone involved – from the producers to the creative team to the effects crews to the cast. Everybody, at one time or another, contributed some idea for how to solve a particular problem – and that always got us through the day."

Flipper
Dolphin Doubles

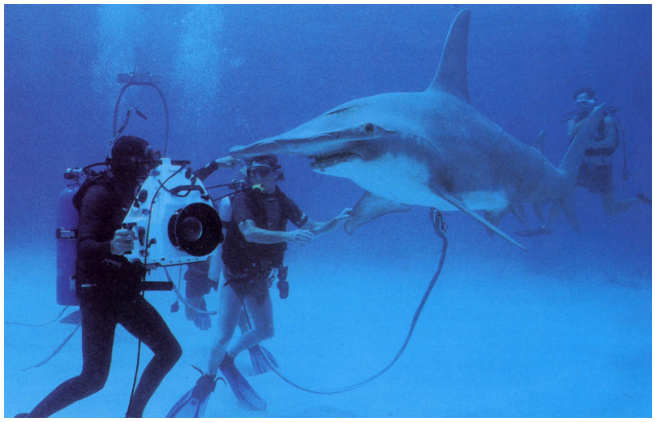
article by David Carey

For most of us, the name '*Flipper*' conjures up images of a charming and wily dolphin swimming playfully in gentle, crystalline waters. Star of a half-hour family adventure series, the character first graced our television sets in the late sixties. Now, thanks to the efforts of a dedicated troop of creature makers and filmmakers, the amiable dolphin is on the big screen in Flipper, a Universal Pictures release starring Paul Hogan and Elijah Wood. Like its small-screen predecessor, the movie centers on the relationship between an adolescent boy and a smarter-than-average dolphin. Unlike previous incarnations, however, this Flipper sports state-of-the-art technologies ranging from sophisticated animatronics to digital effects.

Given a nineties' spin, the story begins with the arrival of a troubled youth, Sandy (Wood), at the island shanty belonging to his uncle (Hogan) – a devil-may-care beach bum who ekes out a living as a fisherman. The city kid's dismay at being sequestered so far from television and rock concerts is allayed somewhat when he befriends a dolphin. Before movie's end, the courageous and mentally gifted Flipper rescues Sandy from a shark attack and uncovers evidence of illegal dumping of toxic waste into the ocean waters, thereby saving the island's fishing industry.

Because of the primitive state of animatronics at the time, the original television series had relied entirely on trained dolphins to portray Flipper. In fact, storylines were often created around whatever dolphin footage the production team was able to capture. Such a random approach would not suffice for the movie, however. The screenplay – written by director Alan Shapiro, with revisions by Robert Ramsey and Matthew Stone – demanded a very specific dolphin performance. There was therefore no doubt that animatronics would be essential to the production. Not only would a controllable, mechanical dolphin be more filmmaking-friendly than a mischievous real animal, the script put Flipper into dangerous situations to which a real dolphin could not be subjected.

Early in preproduction, the filmmakers contacted Walt Conti, founder and president of Edge Innovations, a five-year-old company specializing in highly technical animatronic effects. Conti had earned a sterling reputation for underwater animatronics, masterminding the whales for Star Trek IV: The Voyage Home and both *Free Willy* films. For *Flipper*, Conti and his crew were engaged to design and engineer animatronic dolphins representing *Flipper* and his mother, as well as a fourteen-foot hammerhead shark. The plan was to interchange the animatronics with the real animals for specific shots – without detection. "The challenge," Conti said, "was that we had to create an



Underwater cinematographer Pete Romano prepares to photograph an animatronic hammerhead shark built by Walt Conti and his Edge Innovations crew for Flipper.

exact double of a real dolphin. Our dolphins and the real ones were going to be constantly intercut back-to-back in the same scenes. That meant we had to come up with something that was completely believable."

Preparations included taking measurements and countless photographs of real Atlantic bottle-nose dolphins. Three trained dolphins – named Jake, Fatman and McGyver – were to portray Flipper, under the guidance of trainers Danny Sams, Scott Sharpe and 'Paka' Nishimura. Equipped with the reference materials, Conti and his Edge crew – including project supervisor Ty Boyce, model shop foreman Dave Caldwell, sculptors Stephanie Englert and Jonathan Horton, electricians Alan Cooney and John Williams, and mechanical department members Tom Hsiu, Joss Geiduscheck, Ted Rogers, Greg Richards and Alex Tilson – began addressing both aesthetic and engineering issues.

First, dolphin forms were sculpted to replicate the real animals, down to the last detail. "Dolphins are very active creatures," remarked Conti, "so they get scarred, bruised, bumped and scratched – and we had to match every little scar and every little scratch perfectly." From those sculptures, molds were produced and skins were cast out of Skinflex, a urethane that holds up well in water. The harshness of the environment in which the animatronic devices would be operated had to be taken into consideration throughout every phase of design and construction. "The ocean environment is brutal, and it makes everything corrode. We had all heard the classic stories from *Jaws*, where the shark was nearly ruined by the salt water. Everything we built was designed to account for those kinds of things. All of the materials were specially selected for a marine environment; everything was anodized and coated."

Environmental considerations were also key in the choice of mechanisms to power and articulate the animatronic creatures. "We designed and built battery-powered servos to drive the various functions," explained Conti, "operated via joystick controllers. We had to get a lot of power into these animals to give them the quick-responding performance you would expect from a dolphin. To get that kind of speed, we developed a high-powered thruster system that was strapped onto the dolphin like a 'turbo pak.' That was a new idea for us." Since radio control does not transmit well through salt water, Conti's team also devised a hardwire umbilical system that was attached to the mechanical creature. In postproduction, the umbilical cord was removed from the shots digitally.

Although live dolphins were used throughout most of the film, animatronic replicas were employed for especially difficult or dangerous scenes. (Photos: Chip Matheson)

Each of the animatronic creations was tested in tanks before being shipped to the rough waters of location. "We had to test them for buoyancy, among other things," noted Conti. "We have tanks here at our shop for that. We put the dolphins in the tanks and swam them around to make sure everything was working. We knew that once we got out in the ocean, it was going to be that much harsher an environment."

After completing and testing the animatronic dolphins and shark – a five-month-long project – Conti joined the production team in the Bahamas for several months of principal photography. Unfortunately, Flipper was filmed during the region's most unpredictable weather season. "It wasn't a tank situation where everything was controlled," said Conti. "We were in a real ocean environment, during the worst hurricane season in the history of the Bahamas. We were out there amidst the weather, the waves – everything. And despite that, we never stopped the production or slowed it down because of any mechanical failures."

The animatronics, in fact, proved invaluable in achieving a well-rounded dolphin performance. "Our mechanical dolphins could never do the kinds of leaps and flips and energetic actions the real animal could do," Conti admitted, "but there were many instances in which using the real dolphin just wasn't appropriate. A real dolphin doesn't like doing intimate two-shots with an actor – he'll do them once, and then he's out of there. So whenever the production wanted a subtle, quiet performance – one that could be repeated over and over – they called in the animatronic." The mechanical dolphin was also used in dangerous scenes, such as those revealing an ill Flipper in a sling or fighting with the hammerhead shark.

The production team in the Bahamas included many who were no strangers to the deep. Cinematographer Bill Butler had, twenty years previously, shot Steven Spielberg's *Jaws*. Working closely with Butler was Pete Romano, an underwater specialist who headed up a unit that accounted for nearly twenty percent of the film's shots. Romano's underwater photography credits included *Star Trek IV*, *Jaws the Revenge*, *The Abyss* and *Waterworld*. For twelve years, he has headed his own company – Hydroflex – supplying underwater camera and lighting equipment to the industry.

Romano prepared for his Flipper assignment by reviewing episodes of the old television show. "I also studied the boards thoroughly and had a lot of discussions with the director and the production designer. By the time we got to production, I had a very good idea of what I wanted to do in the underwater photography."

Charged with shooting most of the dolphin scenes, Romano was more than grateful for the reliability of the animatronic creations. "The animatronic dolphin was a great advantage for me as a cameraman," Romano noted. "Typically, animal films are at the mercy of the whims, attitudes and idiosyncrasies of the animals – they get what they get. But I had the advantage of working with an incredibly lifelike animal that was fully controllable. I could position this dolphin in the most beautiful areas of coral and other sea life, and compose the shot exactly the way I wanted it. I could point the camera wherever I wanted, without worrying about where the dolphin was. As a result, I had some of the best dailies of my career on Flipper." As satisfying as the final footage was, however, the shoot was still a grueling one for both Romano and the puppeteering team. "I was out there for ten weeks, six days a week, six to eight hours a day – and that's a lot of diving. We all got pretty beat up, fighting the currents and dragging all the equipment around. The puppeteers were swimming back and forth, pushing five-hundred-pound dolphins with each take; and I was carrying a hundred-pound camera. It was a very physical job."

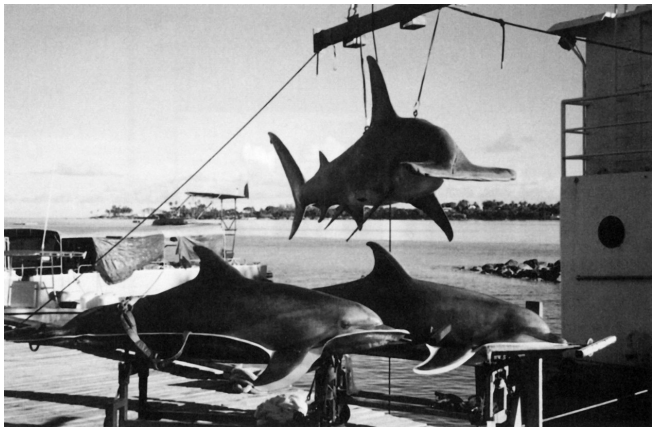
The most challenging sequence in the film, from an effects perspective, was one towards the end in which Flipper engages in battle with a hammerhead shark. Filming of the scene, which took place in water twenty-five feet deep, required the coordinated puppeteering of both the mechanical

dolphin and shark. Additionally, while many of the show's animatronic scenes had been achieved in relatively shallow water, with the puppeteers on the surface, the shark fight required the puppeteering team to don scuba gear. "The scene was very complicated logistically," said Conti. "We had fourteen or fifteen people underwater in scuba gear, operating and coordinating these animatronics."

"Trying to coordinate an animatronic dolphin and shark in open water, with currents and limited visibility, was a real exercise in patience and planning," Romano affirmed. "We had to talk out the shots thoroughly before we went out in the water. Everybody had to know exactly what they were supposed to do – and then they had to do it." The mercurial nature of the ocean did little to help the cause. "The water could change completely within half an hour. The current would come in; and suddenly, there would be all these jellyfish, or some sediment clouding the water. Or suddenly the current would be up to two knots; and there'd be all of these guys out there with umbilicals and joysticks and communications systems – it was like an underwater rodeo."

Conti and Romano were finished on Flipper by the time the crew returned from the Bahamas. For visual effects supervisor Brad Kuehn and the digital team at Cinesite, however, the project was just beginning. The digital effects facility – which had provided remarkably realistic-looking computer generated ocean shots in *Waterworld* – was brought on board the *Flipper* project to complete CG shots, digital composites and a number of digital removals of the umbilicals powering the animatronic dolphins.

A key scene for Cinesite was one at film's end calling for Flipper to join a pod of dolphins. To suggest a multitude of dolphins, filmed images of the live animals and their animatronic counterparts were cloned digitally at Cinesite. "We would shoot the dolphins in different positions in the water," explained Conti, "and Cinesite would composite our shots together. We actually only made two animatronic dolphins, and there were just three trained dolphins – but due to digital duplication, it appears as if there are many, many animals."



Animatronic adversaries await their call during location shooting in the Bahamas.

For Conti, the work on Flipper was enormously satisfying – especially when, at a final screening, he found that he could not distinguish his animatronic creations from their real-life counterparts. "It gave me a real kick," Conti said. "We'd worked very hard to bring every part of this thing together – the engineering and the artistry. Then we see our work on screen and it transcends the sum of the parts. We have created this real character out of metal, rubber and fiberglass. At times, I found myself believing that it was the real thing – even though I knew it wasn't. There is a magic to it that is very rewarding. But at the same time, it is humbling, because you realize that it takes the highest technology and thousands of man-hours to duplicate what mother nature creates so effortlessly."

Sgt. Bilko
Techno-Tank Trickery

article by Estelle Shay

Reviving the character made famous by Phil Silvers in the classic fifties television series *You'll Never Get Rich*, Steve Martin stars as the irrepressible con artist of *Sgt. Bilko*, a Universal Pictures comedy directed by Jonathan Lynn. In screenwriter Andy Breckman's updated story, Ernie Bilko runs the motor pool at Fort Baxter, engaging in assorted scams and rackets on the side to separate his army buddies from their paychecks. When the Pentagon threatens to close the base if its latest research project – a hover-tank designed to ride on a cushion of air – fails to perform, Bilko hatches a bold scheme to bamboozle the visiting brass.

Two key sequences would show the hover-tank in action. The first occurs early in the film, with the arrival of Major Thorn (Phil Hartman), sent by the Pentagon to analyze the device. A demonstration of the tank at a target test site goes comically awry when the recoil from its cannon sends it careening out of control into a section of bleachers. In a later scene involving a second demonstration in front of dignitaries from the Pentagon, Bilko ensures the tank's success by rigging the targets to explode via remote control.

A full-size prop tank was built for the show by Don Pennington; but since no prop could simulate the tank in hovering mode, Lynn turned to Digital Domain for a visual effects solution. "Jonathan had seen some of the work we were doing for Apollo 13, and came to us with storyboards in fall 1994," said Patrick McClung, visual effects supervisor for the production. McClung devised a two-fold approach to the assignment. Certain shots would be accomplished by compositing a miniature tank into background plates of the test site – shot on location in Simi Valley – while others would be realized with the tank model on a miniature set piece built at Digital Domain.

As filming got underway, McClung, accompanied by visual effects director of photography Erik Nash and a small crew, spent three weeks with the production on location overseeing background plate photography for the effects shots. To aid the director in visualizing the shots, McClung devised a simple mockup, consisting of a wooden, tank-shaped cutout bolted to the side of a truck. "Jonathan was unaccustomed to dealing with visual effects," said McClung, "so we needed something that we could drive around the site to get a sense of how fast he wanted the tank to travel and where to position it. First, we would shoot a pass with the mockup and watch it on video playback. Then, once we had the moves down, we would shoot a clean plate."

Stationary cameras were used to photograph all of the backgrounds, with encoders attached to the gear heads to record pan and tilt moves. “The encoders were easy to use,” observed Nash, “and gave us an immediate move file that we could take back and program into our stage cameras, eliminating the need for tracking in post.”

A prototype hover-tank undergoes field testing in a visual effects sequence produced by Digital Domain for Sgt. Bilko.

Back at Digital Domain, a model hover-tank was built to match Pennington’s full-size tank prop. Gathering measurements, photographs and blueprints of the prop for reference, model shop supervisor Leslie Ekker and crew chief Eugene Rizzardi constructed the five-foot-long model in quarter-scale out of tough PVC board applied to a sturdy steel frame. Movable parts included a rotating turret with elevating cannon, and a figure sculpted in the likeness of Steve Martin, motorized for up-and-down movement inside the turret. Stepper motors were operated via a small stepper driver box that could be easily linked to a motion control system. A hand-operated mount provided pitch, roll and turnaround movements, while high-pressure air hoses installed in the model’s vertical thrusters were used to kick up dust.

For shots of the tank lurching out of control and into the bleachers, the model was filmed on a raised forty-by-sixty-foot set piece erected by Rizzardi in the Digital Domain parking lot. “We had originally planned to do those shots as total composites, using the real bleachers on location,” said McClung, “but in examining the plates, we noticed that there were natural breaks in the terrain that went completely across frame, which would allow us to do a kind of hybrid composite between our set and the real location. That way, we could get all the flying dust and dirt and other elements physically interacting with the tank, instead of trying to composite them in later.” To facilitate the blend, the set was dressed with ground hay and fuller’s earth to match the real terrain. “We dressed the hay right up onto a giant greenscreen that was dropped behind the set to create a natural break.”

To move the model so it would appear to be hovering, a track system was installed underneath the set. “It was a track left over from *True Lies*,” McClung explained. “We attached a solid pole to it, connected the pole to a U-joint, and ran it up through a slot in the set to our miniature tank above. Since the tank was designed to hover less than two feet from the ground, the pole would not be visible in the shots.”

As the scene begins, the tank lifts off, lurching and bumping. One of its horizontal rear engines promptly fails, spinning the tank counterclockwise

and spewing dust into the faces of the commander and his guest. To line up the shot – a POV from a ridge looking down at the test site, with a small pond in view – McClung put a clip of the background plate in the camera. “Fortunately, the pond was man-made, so it had a nice hard edge to it, which provided a good, natural break.”

Alfa-1 is propelled into the skies over the plains in a shot at Digital Domain.

As the hover-tank’s cannon fires at a target, the recoil pitches the tank into reverse, sending it careening out of control. In a shot subsequently cut from the movie, the run-amuck tank smashes into a large troop carrier. A quarter-scale replica of the carrier was used for the crash, rigged from under the set to collapse upon impact.

The tank then sideslips towards a section of bleachers filled with army technicians observing the demonstration. As the tank bears down on the bleachers, one female recruit remains rooted to the spot while others scramble to safety. With the tank nearly upon her, the recruit springs to action just moments before impact, vaulting to safety. To film the segment, McClung shot the destruction of the bleachers first, employing a Personal Animation Recorder system – developed by Digital Processing Systems – to help with alignment. “The PAR is basically a souped-up Amiga computer that allows you to record video at a slow frame rate, then play it back in real time,” explained Nash. Three sets of miniature breakaway bleachers were constructed by Rizzardi for the shot. “We put air mortars under the set and fired debris up into the bleachers to give the explosion a little more force. It was a bit over-the-top, but that was intentional. The idea was that just the thrust coming from the hover-tank’s engines was enough to tear the bleachers apart.”

For a shot of the tank bearing down on the recruit, a stuntwoman was enlisted to perform the live-action on a greenscreened set. “We laid down our greenscreen like a giant cyclorama, on the floor of our outdoor set,” said McClung, “covering the route that she would run. Then we welded up steel bars painted green for her to grab hold of and go flying over.” Using the PAR, the stuntwoman’s actions were timed to sync with the footage of the runaway miniature tank and exploding bleachers. The greenscreen footage was then composited with the model photography.

While scenes featuring the tank careening out of control were shot on the outdoor set, the effects team moved indoors to film its more controlled maneuvers. On stage, Nash mounted the model on a modelmover and photographed it against an orange screen. “We used orange instead of blue or green,” Nash explained, “because the orange provides a softer quality edge to the mattes. Also, we were illuminating with ultraviolet light, and we get better exposure off of fluorescent orange than we do off green or bluescreen.” Once again, the PAR was used to insert the miniature tank into the live-action. “We had the background plate on one PAR; and, using a low-end video switcher, we’d take a video tap feed off the motion control camera, running the motion control in sync with the playback at one or two frames per second. Then we recorded that composite on a second PAR and played it back at 24 frames per second. We could dub a tape and send it to the director for his feedback on whether or not the moves were working.”

From the turret, Bilko fakes a demonstration of the hover-tank’s firepower by triggering a flamethrower at the same moment his buddies detonate a remote-controlled explosion at one of the target sites. The fireball erupting from the cannon barrel was realized as a practical effect using

the full-size tank, elevated on metal risers eighteen inches off the ground. “To save our digital artists from having to paint out the risers, we resurrected an old trick used for the landspeeders in *Star Wars*,” explained McClung. “Since both the tank and the camera were locked off, I was able to mount a plastic mirror on a piece of plywood under the tank, and adjust it to reflect the ground. Shot at a particular camera angle, the tank appeared to be hovering.”

At one point, the tank hovers over a small pond as it fires at a second target. Ripples in the water from the thrusters were accomplished during plate photography, with the aid of a helicopter. “We shot two or three passes of the aircraft hovering low over the water for maximum disturbance. Then we filmed a clean pass, so that we could remove the helicopter in post and replace it with our tank.”

Separate stage passes were shot for elements such as shadows, dust and mist. “Adding the dust proved to be a bigger nightmare than I had anticipated,” explained McClung, “because we needed to match the look of the fuller’s earth used in the location shots. But real fuller’s earth couldn’t be used because it would show up on the black background we were shooting against.” CO2 shot from a fire extinguisher into a trash can proved an ideal substitute. “The CO2 wafted up from the trash can through an inch-tall, three-foot-long black box built in the shape of the tank bottom and mounted on a stepper motor. That allowed us to mimic the motion of the tank. Once we got the white CO2 pass, it was scanned into the Flame and warmed up colorwise to look like dust.”

To create the illusion of mist streaming off the surface of the pond, an airbrush was used to direct a fine spray of water onto a large table covered with black plastic. “The plastic was filled with an inch of water so that you wouldn’t see the droplets building up,” noted McClung. “The mist would just hit the water and disappear.”

To film a shadow pass, the effects team built a white foamcore floor consisting of two L-shaped pieces laid under the miniature tank on the motion control stage, with the modelmover coming down between the two pieces. “Using just a key light,” explained Nash, “we shot the tank with the white floor under it, then garbage-matted out the tank, extracting just the shadow off the foamcore. Our digital artists then applied that shadow to the background under the tank.”

Heat distortion – supposedly emanating from the hover-tank’s vertical thrusters – was another element essential to selling the hover-tank shots. Working with David Isyomin – who had developed distortion software for the Harrier jump-jet shots in *True Lies* – lead digital artist Simon O’Connor added multiple layers of heat and soot elements to simulate the heat distortion effect. “It involved a complicated optical shift,” McClung stated, “with small lenses distorting the background image.” To ensure that the heat distortion was hitting the ground in the right spot, O’Connor created a 3-D wire-frame version of the hover-tank in the computer, tracking it to the miniature tank.

In digital postproduction, digital effects supervisor Gray Marshall and lead compositors Jammie Friday, Mark Loso and Carey Villegas performed the bulk of the compositing work, digitally inserting the tank into background plates, removing the helicopter, softening matte edges, creating soft splits and, finally, layering in the dust, shadows and mist.

Sgt. Bilko marked Pat McClung’s induction into the ranks of visual effects supervisors, and his first significant foray into digital effects. “It was an eye-opening experience. I found myself going through a real learning curve. There would be times when the production would ask, ‘What about the grading on the scans?’ And I’d have to say, ‘Well, let me get back to you on that.’ Then I’d go see

Gray Marshall, and he'd explain that part of the process to me. Fortunately, I had a lot of really good people on my team."

White Squall
Stormy Weather

article by Estelle Shay

In *White Squall*, a Hollywood Pictures release directed by Ridley Scott, an adventurous year at sea on a brigantine sailing vessel becomes a harrowing rite of passage for thirteen teenage boys when a freak storm claims the ship and the lives of six of its crew. Starring Jeff Bridges as Christopher Sheldon, the brigantine's tough and taciturn captain ultimately held accountable for the tragedy, the film is based on an actual incident that occurred in 1960 on the Albatross, a floating prep school bound for home after a year-long voyage in the Caribbean and South Pacific.

Crucial to the tale of the doomed ship is a riveting storm sequence depicting the vessel being battered and sunk by a freak weather condition known as a white squall. Tasked with orchestrating the seventeen-minute sequence was special effects supervisor Joss Williams, a twenty-year effects veteran whose most recent work was in the large-scale action epic Judge Dredd. On a limited budget this time, Williams would opt to accomplish the *White Squall* effects entirely in-camera, using a combination of miniature ships and full-scale floating set pieces.

Preparations for the live-action shoot were begun at Shepperton Studios in March 1995, as Williams, assisted by effects administrator Michael Dawson, gathered together his crew. Under workshop coordinator Stephen Cullane, metal frames were fabricated for three main ship sections from mechanical designs created by Brian Morrison. The completed frameworks were shipped to Mediterranean Film Studios in Malta, whose unique water tank facilities were ideally suited for staging the large-scale tempest. There, the effects team – which included Maltese production designer Les Tompkins and construction coordinator Michael Redding – continued to work on the set pieces for another ten weeks prior to the production's arrival in June.

Largest of the pieces was a full-scale exterior section of ship replicating Eye of the Wind, a 110-foot topsail schooner used in the film to represent the Albatross. "Most of the storm action happens at the blunt end of the boat," noted Williams, "so our set piece went from just past midship all the way to the stern." To ensure its ability to withstand the trauma of thousands of gallons of water being dumped onto it, the vessel's superstructure was securely affixed to a framework of reinforced steel. The completed construct – weighing nearly fifty tons and measuring seventy-five feet long by twenty-five feet wide, with a fifty-foot-tall section of mast – was mounted on a pivot rig designed to rotate through ninety-five degrees.

Effects supervisor Joss Williams used full-scale set pieces and miniatures to recreate the fatal freak storm that sank a sailing ship crewed by teenagers in the fact-based White Squall.

In addition to the principal ship exterior, six smaller set pieces – five of them interiors – were built for scenes involving specific crew members trapped on or below deck as the storm hits. "Those were also designed to be submerged, to one degree or another, and revolve through forty-five degrees or more."

With the arrival of cast and crew from location shooting in the Caribbean, filming began in the studio's shallow tank – a three-hundred-foot-long reservoir, two hundred fifty feet across, with a seventeen-foot deep zone. Although Williams had intended to shoot the sequence in the facility's deep tank – touted as the largest surface water tank in the world – a switch was necessitated when the production's insurance carriers determined it potentially unsafe. "The big tank ended up as a reservoir for clean water," Williams remarked. "We would pump water from the sea into it, have it chlorinated and purified, then use that to refill the shallow tank whenever it had to be drained." Plans to film the sequence at night were abandoned in favor of a daytime shoot. "After we did some tests, Ridley and director of photography Hugh Johnson decided that the sequence would work better in daylight, as long as we could ensure big enough storm effects."

To depict the fierce squall conditions, Williams and senior effects technician Kevin Draycott relied on a variety of storm-making equipment. "Ridley was going for maximum on everything, so we just tried to give him as much as we could," Williams commented. Tip-tanks mounted on forty-foot-high towers dumped up to fifteen tons of water at a time into the tank, while wave machines generated pounding ocean swells. Although the facility came equipped with rain towers, the effects team used fire hoses sprayed in the air – a simpler, more maneuverable method of simulating rain. Lashing gale-force winds were generated by two jet engines working in conjunction with prop engines. "One was built from scratch, but we located the other in England – an old Comet jet engine with about 4000 pounds of thrust. We mounted it on the back of an old army vehicle; and it gave us terrific wind and wave effects, generating waves between four and six feet high in the deep section because of the tremendous force of the jets blowing across the top of the water." Smoke effects added atmosphere, while masking out undesirable backgrounds.

A full-size aft section of the vessel is hoisted into position at a tank facility in Malta.

As the first blast of the storm hits, shots of the Albatross listing at a forty-five degree angle were photographed with actors on the full-size set piece, mounted on its pivot rig. "That was a tense moment for us," Williams recalled, "as it was the first time

Tip-tanks aloft on towers – coupled with wave generators and gale-force wind machines – provided a pounding simulation of the deadly storm.

we'd attempted to rotate our rig to such an extent in the water. We knew it would work because we had tested it dry – but not with all the props, ropes, sails and other dressing." A simple cable system was used to power the rig through the water, with a big Caterpillar tractor – running outside the tank along the wall – pulling the boat down into the water and back up again through a series of pulleys and cables. "It was simpler and easier than using hydraulics. If something were to go wrong, it would be a simple fix; whereas a valve or a seal break could spill hydraulic fluid in the water and require draining the tank."

Now caught in the full force of the squall, the brigantine lists to a ninety-five degree angle, its mast resting slightly underwater. "Once we started the storm," Williams related, "we had to bring the jets up. But when we tipped the boat to ninety-five degrees, the exposed hull acted like a barrier, stopping the wind from reaching the actors. So we had to do a major cheat and bring the wind machines around to the other side as well."

From its horizontal position in the water, the ship lurches back to an upright attitude, its deck awash. Flooded views were accomplished by draining the tank and removing portions of the ship section's base. "We brought in two of the biggest cranes in Malta to lift the entire rig off of its pivot points, and took out a number of six-foot-high removable metal sections that had been built into the base. When we refilled the tank and put the boat back in, it sat six feet lower, with water spilling two-and-a-half feet over the deck."

Scenes below deck during the storm were shot on interior set pieces dropped into a sectioned-off corner of the shallow tank. "We built a seventy-by-fifty-foot wall section to create a tank within the main tank," observed Williams, "and shot those scenes during times when the rest of the tank was being drained." For a sequence in the corridor – where several boys are caught as the ship capsizes – underwater cinematographer Pete Romano shot the actors in a seventy-by-fifty-foot set, rotated via cable and hydraulic winch a full 180 degrees. A scene in which Sheldon's wife is trapped in a cabin of the sinking ship was accomplished with actress Caroline Goodall in another hydraulically driven set piece pivoted eighty-five degrees. For a cutaway shot of her husband peering frantically through a skylight into the cabin, a small eight-foot-square fiberglass tank was constructed. "We filmed Jeff Bridges in it, filling the bit that he put his face into with fresh water."

Another interior set piece, built to represent the sleeping quarters, was constructed as a rocker set and engineered to rotate from zero to forty-five degrees. "We shot that on a stage at the studio," said Williams, "pumping water in to get the effect of its being swamped as the ship goes over." An eleventh-hour request from Scott – for a shot in which one of the boys get dragged underwater as he attempts to lower the lifeboats – required some improvisation by the effects crew. "It was at the end of our stint in Malta, so we literally chopped off the back end of our full-size rig, stuck it on a trolley and pulled it underwater."

For full-length exterior views of the Albatross pitching ninety-five degrees in the ocean swells, Williams used a quarter-scale miniature built by Effects Associates at Pinewood Studios in England. The hydraulically powered twenty-four-foot model was mounted on a rig in the Malta tank and

filmed high-speed. “We used hydraulic controls this time because it had so many different movements in it that Ridley wanted. We had it pivoting through its access from port to starboard.”

Effects Associates was also tasked with building an eight-foot-long model for underwater shots of the boat tipped upside-down. Photographed in a tank at Pinewood following completion of the six-week Malta shoot, the smaller model enabled Williams to capture a view from beneath the mast of the fully capsized vessel. “The real ship is as tall as it is long, so our larger quarter-scale version – which was twenty-four feet tall – would have required a tank with a minimum depth of thirty-four feet in order to position our cameras far enough away from the mast.”

Having relied purely on physical effects to accomplish the storm sequence, Williams was pleased that only a few lightning flashes needed to be added in postproduction. “It’s not that I believe in avoiding the use of visual effects; I just think they should be applied in the right situation – when there’s something we can’t do. Ridley always had it in his mind that he’d have to embellish the sequence with cloud overlays and such. But when he saw the rushes, he was happy enough with what we gave him not to enhance it optically. So we saved the production quite a bit of money.”

Gulliver's Travels
A Brobdingnagian Endeavor

article by Estelle Shay

In 1986, while on staff at Jim Henson Productions, Duncan Kenworthy produced a television series called The Storyteller, with actor John Hurt narrating stories based on classic Brothers Grimm fairy tales. The show was, in many respects, ahead of its time. "It had an unusual visual style," related Kenworthy, "and a lot of effects borrowed mostly from music videos. After the success of that venture, a producer friend of mine said, 'You have these fantastic techniques for storytelling – have you ever thought about doing Gulliver's Travels?' I hadn't read the book since my days at Cambridge, but I was interested enough to look at it again and consider how one might do it."

Intrigued by the timelessness of the Jonathan Swift satire, Kenworthy became convinced that the key to a successful screen adaptation would be to make Gulliver the teller of his own life story. "One of the advantages of a storyteller technique is that it allows you to moderate the amount of time spent on effects," noted Kenworthy. "In The Storyteller, we had a lot of scenes in which John Hurt was just talking to camera; and we only needed to visualize certain parts of what he was describing." Adopting a narrative approach would also make it possible to create a more dramatic through-line. "In some ways, Gulliver's Travels is very static. It has many marvelously imagined adventures; but the way they are linked to one another is not very complex, and the only real drive of the story is the question of whether or not Gulliver will return home. Turning him into a storyteller allowed us to create a drama that was stronger than the drama in the book." Ultimately, the completed script, by Simon Moore, would embrace all four sections of the original work – two of which had never before been adapted for film – and weave them into a parallel story of Lemuel Gulliver's troubled return home after an eight-year absence.

Not surprisingly, the idea of a television miniseries based on Gulliver's Travels was not an easy sell. "An expensive miniseries – especially one based on an eighteenth-century novel – was the last thing one could possibly hope to finance," Kenworthy allowed. "People were only interested in half-hour, reality-based series that were cheap to produce. But I kept plugging away. It became sort of a folly after a while. I'd bring it up in staff meetings and people would just roll their eyes."

In 1993, Kenworthy took time off from Henson Productions to produce the surprise blockbuster Four Weddings and a Funeral. Basking in the success of that undertaking, he cautiously renewed his efforts on behalf of Gulliver's Travels – but was still unable to generate any interest. His options all but exhausted, the frustrated Kenworthy finally confronted Bill Haber, a senior agent at Creative Artists Agency, representing Henson Productions. "I said: 'Look, I just made a movie that cost $4.5 million. Nobody wanted to do it; nobody believed in

it; no one in the States thought it would ever sell – and it's grossed $260 million worldwide. What else do I have to do to get some credibility?'" Within two months, Haber put him in touch with executive producer Robert Halmi, Sr. – who had sold NBC on the idea of a four-hour miniseries – and a collaborative venture was launched.

Lemuel Gulliver (Ted Danson) – shipwrecked and cast ashore in a strange land – awakens to find himself trussed and staked to the ground by a swarm of tiny Lilliputians in Gulliver's Travels, a four-hour television miniseries from Jim Henson Productions.

With Ted Danson in the title role, a stellar supporting cast and a budget just under $20 million, work on Gulliver began at last in January 1995. Director Charles Sturridge and Kenworthy had just three months in which to determine how their resources might best be used to realize the effects-laden script. "Viewers today are so sophisticated – children in particular – that we knew we'd have to use a whole range of techniques to keep them guessing," Kenworthy commented.

Scenes of Gulliver among the tiny Lilliputians and giant Brobdingnagians – some 450 shots in all – were provided on a tight television schedule by FrameStore, a digital effects facility situated in London. Since motion control was not employed on set, extensive motion tracking was required to align blue- and greenscreen elements with live plates and miniatures.

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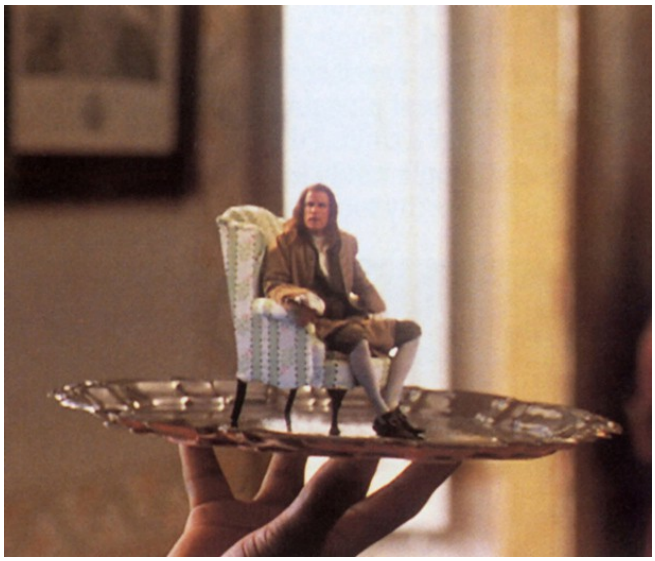
After considering several effects companies, Kenworthy and Sturridge awarded the assignment to FrameStore, a ten-year-old London-based firm. To deliver the show's 450 shots, effects supervisor Tim Webber would employ a full complement of tricks – from animatronics and models to motion tracking and computer enhancement – and would rely heavily on bluescreen and digital compositing techniques. "The main thing we wanted was total believability," stated Webber. "That meant paying meticulous attention to details, like shadows and reflections – all the little things that the eye notices subliminally."



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Because the majority of the effects involved scenes in which Gulliver was either a giant among tiny Lilliputians or a tiny being among gigantic Brobdingnagians, issues of scale were paramount in determining the effects strategy. "We tried to imagine how we would shoot a scene in Lilliput if Gulliver really was seventy-two feet tall, and we – as Lilliputian filmmakers – were all just six inches tall," commented Webber. "Normally, when you're filming small things, you go for a much reduced depth of field. But if we imagined our camera was Lilliputian-size, then we would use normal depth of field on the Lilliputians. Conversely, a camera of Brobdingnagian proportions would require shooting Gulliver with a reduced depth of field to accommodate his small size."

In general, Webber and his FrameStore crew found scenes of Gulliver amongst the Lilliputians to be the most challenging. "Shots of Gulliver as a giant were hardest to accomplish because he had a much bigger effect on the environment around him." To support the illusion, live-action footage of flying birds was layered into many of the scenes featuring the giant Gulliver moving about Lilliputian exteriors. "Birds are sort of subliminal reference points for scale," said Kenworthy, "so we used them in almost every shot where we were trying to make Gulliver believable as a giant."

A shot of Gulliver peering into a Lilliputian palace window was typical of the challenges encountered by the effects team. Interiors were shot at Mafra, a palace in Portugal, with actors playing bustling Lilliputian courtiers. "We wanted Lilliputians crossing in front of the window as Gulliver's face came into view," noted Kenworthy. "That way, it wouldn't look as if all we were doing was matting a square window frame into the shot." To achieve the shot, a greenscreen was mounted outside the window on location, hung from a huge scaffolding rig. Forty feet long and three stories high, the rig was set back enough so that the greenscreen could be lit independently, without its color reflecting on the actors inside. To simulate the effect of Gulliver's appearance in the window blocking the sunlight, an enormous flag was attached to the outside light source. When lowered on cue, the flag cast a shadow onto the palace floor. "It wasn't a splashy effect – but we felt it was important enough to warrant the outlay of expense and effort."

Physical interactions between Gulliver and his tiny captors also helped to sell the effects. For a scene in which Clustril climbs onto the face of the sleeping Gulliver, actor Nicholas Lyndhurst was filmed on a huge polystyrene head covered in blue cloth. “We didn’t have the time or budget to sculpt an exact replica of Gulliver, so we approximated it,” explained Webber. “Then we shot Ted separately, using small sticks to poke indentations in his face for footprints.” In postproduction, the polystyrene head was replaced with Danson’s filmed head, with digital artists adding shadows and adjusting the footprint indentations so that they lined up with the Lilliputian’s footsteps.

Scenes of Gulliver among the giant Brobdingnagians were generally realized by filming Danson against bluescreen, shrinking him down and dropping him into background plates. Ensuring proper perspectives for the bluescreen photography within the confines of the studio often entailed clever camerawork. “In theory, with a scale of twelve-to-one, the camera should have been twelve times farther away from Ted when we were shooting him in the studio than it was when we were shooting the backgrounds,” observed Webber. “But that often meant the camera needed to be two hundred feet up in the air, five hundred feet back – and our studio wasn’t nearly big enough.” To compensate, Webber found ways to cheat camera angles and positions. For example, an up-angle shot of Gulliver teetering on the edge of a Brobdingnagian table – hypothetically fifty feet high – was achieved by positioning Danson a mere twelve feet in the air. The action was captured with a camera mounted above a mirror on the floor, filming his reflection. “That gave us the same perspective as we would have gotten had he been fifty feet up.”

Adding to the complexity of the workload were frequent moving camera shots, requiring motion tracking in postproduction. “Charles didn’t want to use motion control during the live-action shoot,” Webber observed, “because it tends to be unwieldy and time consuming, and we were on a very tight schedule.” Shots of Gulliver sitting in a chair on a silver tray – carried aloft by a Brobdingnagian hand – required precise motion tracking to lock him firmly into the scene. “When we shot the tray, we attached a wire with two crosses on it so we could track the movement caused by the slight shaking and twisting of the actor’s hand. Then we applied that same twisting motion to Ted Danson, shot bluescreen sitting stationary in a normal-size chair.” In postproduction, digital artists painted the wire out of the background, then added some reflections in the surface of the tray.

One shot featured Gulliver jumping from a box onto the extended finger of his young friend, Glumdalclitch. Actress Kate Maberly was filmed with her finger outstretched and steady, then bobbing up and down slightly, as if the tiny Gulliver had landed on it. Danson’s stunt double was filmed jumping from one bluescreen platform to another. “In post, we married the shots and digitally repositioned and stretched images so that everything lined up,” said Webber. “We retimed bits so that the speed with which the finger bobbed up and down matched the speed one would expect to see if an object the size of Gulliver landed on it.” Further digital enhancements included Gulliver’s shadow on the finger and his reflection on the shiny wood floor.

Scenes of Gulliver talking to Glumdalclitch from his quarters inside her dollhouse required multiple layers composited together. One element consisted of Danson, photographed on a full-scale dollhouse set. The second was Maberly, shot bluescreen. And since scheduling problems precluded filming the young actress on location, her image had to be composited into a third element – a background plate. Shots of Glumdalclitch opening the dollhouse door required precise timing of the actress’ arm movements to the movement of the full-scale set door that had been rigged to open automatically. For oblique views of Gulliver standing on a second-story

landing of the dollhouse, Danson was photographed on a bluescreen stage, his image matted into a real dollhouse. "Ted's performance really helps to sell those shots," said Webber. "He leans out and looks up at Glumdalclitch, making you believe he's standing on a real structure, when actually there was nothing there at all."

At the FrameStore facility, visual effects supervisor Tim Webber and effects editor William Bartlett study a composite in progress.

One of the most difficult sequences to stage was one in which Gulliver is attacked by gigantic Brobdingnagian wasps. "Our touchstone for that scene was to make it as realistic as possible," said Kenworthy. "We investigated all sorts of ways of doing the wasps – including CGI – but eventually decided to use real wasps and matte them into the shots." Commissioned to photograph the wasps, Oxford Scientific Film collected several hundred of the stinging insects and shot them high-speed as they flew about randomly inside a two-foot-square glass box backed with a bluescreen. Compressed air sprayed along the glass discouraged the insects from crawling up the surface. In postproduction, the footage was scanned into the computer where digital artists could manipulate flight patterns.

Animatronic wasps – built and puppeteered by Jim Henson's Creature Shop, under the supervision of Neal Scanlan – were used for shots of Gulliver cutting down two of his attackers with a sword-size toothpick. "The animatronics were a great backup for us," said Kenworthy, "even though we were able to restrict their use to just a few shots." Two fully-articulated rod puppet wasps were created – one for a shot of Gulliver skewering a wasp, overturned with its legs kicking wildly, and the other for a shot of his slicing one of the hovering insects in half. "That one was built in two sections and mounted on separate rods. Two puppeteers controlled the abdomen, and two controlled the head. When the sword hit, they separated the halves and dropped them to the floor." Morphing techniques applied in postproduction eased the transition from real wasp to animatronic.

As elements were completed, a system was devised for quickly assembling rough composites so that editor Peter Coulson could drop them into a preliminary cut of the film, edited on Lightworks. Once those sections of the edit were approved, the rough composites were thrown out and remade from scratch at FrameStore, some taking up to three days to perfect. "With 450 shots to contend with, you'd think it would have been a nightmare," commented Kenworthy, "but it was a really smooth process. FrameStore was absolutely fantastic. I never felt that things were being rushed or given short shrift."

Broadcast over two nights in March, Gulliver's Travels won raves and special kudos for its inventive and dazzling effects. The ratings success of the show was especially sweet for Duncan Kenworthy, whose unwavering vision had guided the project from written word to finished film. "Before the broadcast," remarked Kenworthy, "NBC said to us, 'If this fails, no one will be able to do anything like it for another ten years; but if it succeeds, it will change the nature of network television.' Sure enough, after it aired, Lindy De Koven, head of miniseries at NBC, told me that within forty-eight hours she had been pitched every work of English literature from the past two hundred years."

HEART AND SOUL

image

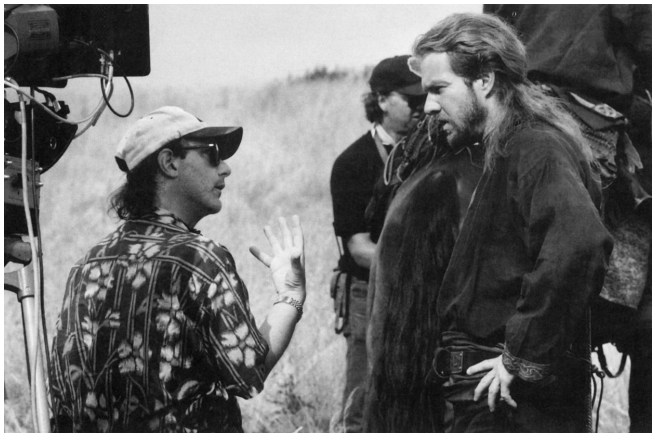
article by
Jody Duncan

When producer Raffaella de Laurentiis sat in a darkened theater and watched the dinosaurs of Steven Spielberg's Jurassic Park lumber across the screen, she did not simply witness the unveiling of unprecedented computer generated effects – she saw, to her delight and astonishment, the means by which her pet project could finally be realized.

For five fruitless and frustrating years, de Laurentiis had been approaching studios to pitch Dragonheart, a poignant 10th-century tale about a disillusioned knight, a wise old dragon, and the friendship that develops between them. Blending elements of fantasy, adventure, mysticism, magic, romance and humor, the high-caliber screenplay by Charles Edward Pogue – from a story by Pogue and Patrick Read Johnson – was well received by studio executives; yet all expressed doubts as to the feasibility of creating a dragon that could walk, talk, fly and express a human range of emotion.

Those fears were confirmed when a puppet test was commissioned from the Jim Henson Creature Shop. Although the test was impressive, given the limitations of the approach, studio executives remained unconvinced that a puppet would ever be able to carry the role. One after another passed on the project, claiming that Draco the dragon simply could not be brought to life. But de Laurentiis possessed extraordinary will; and, with Jurassic Park, she found the way. Not long after that movie's release, Universal Pictures – from whom the producer had finally secured a tentative development deal – engaged a number of effects companies, including Industrial Light & Magic, to produce a computer animated dragon test. At ILM, the assignment went to late visual effects supervisor

A cinematic fable set in the 10th century, Dragonheart recounts the story of a dragonslayer and his friendship with earth's last surviving dragon. Despite a consensus among studio executives that the talking, expressive dragon called for in the script could not be invoked through existing effects techniques, producer Raffaella de Laurentiis continued to champion the screenplay for a number of years. The means by which Draco the dragon could be realized revealed itself at last with the advent of highly sophisticated computer animation.



With a greenlight from Universal Pictures and a budget of nearly $60 million, Dragonheart went into production in 1994, helmed by director Rob Cohen and starring Dennis Quaid as dragonslayer Bowen and Sean Connery as the voice of Draco. Cohen and Quaid confer on location in Eastern Europe.

Steve Price and animators James Straus and Jim Mitchell. “We had only two weeks to complete this test,” Straus recalled. “We didn’t have a dragon model and we didn’t have a technique for doing lip-sync – but we had to come up with something in that two-week period. So we took the T-rex model from Jurassic Park and quickly modified it, yanking its brows around to create horns. Then we took the wings off the pterodactyl model from The Flintstones and stuck those on. We were cutting and pasting, trying to come up with something that looked remotely like a dragon. What we ended up with was incredibly primitive, by today’s standards, but it was promising. When we showed it to Universal, the response was very enthusiastic. Everyone was amazed by it. Considering the limitations we had then, I can’t believe we actually pulled it off.” The successful test resulted in Universal’s greenlighting Dragonheart and ILM being awarded the visual effects assignment.

By the time Dragonheart was officially a ‘go,’ Rob Cohen had signed on to direct the film, reprising the unofficial partnership with de Laurentiis that had, a couple of years earlier, resulted in Dragon: The Bruce Lee Story – a surprise hit with both critics and audiences. Scheduling was such that Cohen and de Laurentiis had only a few months in which to hire department heads, scout locations, cast the film and design the dragon. Physical effects veteran Kit West was engaged to handle the film’s on-set effects, including large-scale firestorms, a flight sequence and numerable interactive gags that would help to sell the CG dragon shots. Visual effects veteran John Swallow was also brought in to act as liaison between Cohen – an admitted effects novice – and ILM.

Lured by its beautiful landscapes, castle ruins and low production costs, Cohen and de Laurentiis commenced location scouting in the Eastern Europe country of Slovakia, where they found suitable exteriors and a state-of-the-art movie studio. The filmmakers were equally blessed in finding a cast. Dennis Quaid agreed to take on the leading role of the knight Bowen, and no less a star than Sean Connery would provide the voice for Draco. Supporting cast members included David Thewlis, Julie Christie, Pete Postlethwaite, Dina Meyer and Sir John Gielgud, who consented to serve as the voice of King Arthur.

For the design of his dragon, Cohen turned to Phil Tippett, a noted creature designer and animator who had tread similar ground with his animation and conceptual work for the 1981 Matthew Robbins film, Dragonslayer. “Raffaella called late in 1993, right after Rob had been assigned the movie,” Tippett recalled. “I’d looked over the script, so I understood what kind of movie they were making – basically, a buddy picture. Eventually, they both came up to talk to me; and Rob and I really clicked. We spoke the same language, and he seemed comfortable entrusting me with finding a character and personality for the dragon.”

Working with renowned illustrator Doug Henderson and his own Berkeley-based Tippett Studio crew – particularly sculptor Pete Konig – Tippett began the months-long process of designing the dragon for Dragonheart Unlike the one-dimensional, fierce dragon in Dragonslayer, Draco was one of the heroes of the film, and would express all the emotions of any human character. For those reasons, Tippett wanted to avoid an overly reptilian look in the design, and leaned more towards a human quality, particularly in the dragon’s face. “Our job was to make an archetypal dragon that could act,” Tippett said. “Draco was much more than just a threatening primordial beast. For one thing, he had to talk – which automatically presented design problems. There aren’t very many facial types that allow for speech, so there was a great deal of thought that had to go into the design of the face and mouth. To accommodate the dialogue, we came up with a muzzle area that was

something between a highland gorilla's mouth and a human mouth. We also gave him retractable teeth so that he could look threatening at times, then tender at other times. That was always the difficulty with this character – he had to show a whole range of emotions and attitudes."

Another problematic area of the design was the dragon's wings. Flying scenes mandated a wing that was both visually appealing and physiologically sound for a creature of Draco's size. After much consultation with Cohen, the dragon's height had been set at eighteen feet – large enough to suggest the creature's power, yet small enough to allow Cohen to frame dragon and knight together in medium shots. "We calculated how big the wings would have to be to make something of this size actually fly," Tippett explained. "We figured he would need a 125-foot wingspan – which was too big to be practical. So we played with that, minimizing the wingspan as much as we could without making the dragon look ridiculous. We also had to work out the engineering problem of how the wings would fold in and expand, making sure they looked good in both configurations. In some of the designs, the wings looked great when they were out and flapping; but once we folded them in, they looked all wrong. A lot of effort went into figuring out what would work functionally, both in a flying mode and a terrestrial mode."

In the end, many of the design problems were solved simply by altering the dragon as needed for each particular shot – a solution facilitated by the flexible nature of digital effects and by what Tippett referred to as 'the Lassie factor.' "There were twenty different Lassies, and they looked entirely different to the trainers," Tippett explained, "but to the audience, they all looked the same. Audiences had never seen Draco before, so they wouldn't notice small differences. I told Rob he could change the scale a little from shot to shot if he had to, or fiddle with some of the dragon's physical characteristics as needed. As long as the shots worked, the audience wouldn't notice. In fact, that was one of the advantages of working with computer models rather than conventional models – Draco could be changed easily from shot to shot." Tippett's philosophy ultimately provided the solution to the wing design. One dragon was sculpted with the wing in the closed position, while a different configuration was sculpted to represent the wings in flight. Making the transition between the closed and open wings was a problem that was left to the ILM digital team.

Over the course of several months, Tippett Studio produced a number of sculptures and maquettes, refining the concept with each new iteration. What the studio finally delivered was a dragon with a thick neck, a powerful chest, an expressive, slightly anthropomorphic face, and a scaly, colorful hide that shimmered with a golden, iridescent sheen. Draco was beautiful and awe-inspiring – and arguably the most complicated design ever conceived for a CG model. "We showed the final maquette to Rob," Tippett recalled, "and he said: 'That's it! That's it!' He was very excited – but I could just see the faces of the ILM guys drop: 'Oh, my God …' I knew this design was going to be a pain in the ass for them when I was doing it; but it was what Rob wanted. I kept their requirements in mind, but I didn't let the tail wag the dog. Engineering, whether it is computer generated or practical, has to come second to design."

Turning over a five-foot-long dragon maquette to ILM, Tippett concluded his design duties and shifted his attentions to creating computer generated animatics. Specifically, Tippett had been charged with providing a key action sequence – a long battle between Bowen and Draco – to help Cohen and crew visualize the scene during filming. "I showed Raffaella some of the animatics we'd done for Jurassic Park," recalled Tippett, "and she said: 'I want those on the set.' Rob hadn't had any

experience doing a visual effects show, and they both thought the animatics would be helpful. The animatics enabled them to visualize the fight sequence in more depth than they could with just storyboards. They also provided a basic template for establishing procedures and methodology for the rest of the show." Digital artists at Tippett Studio – which, since Jurassic Park, had broadened the scope of its services to include digital effects – built simple sets in the computer, based on location photographs, and then animated two-dimensional representations of Draco and Bowen engaged in battle. "We knocked out the animatics in a couple of months, outputting everything on 3/4-inch tape."

In the months prior to principal photography, Cohen engaged Phil Tippett and his Tippett Studio to design the dragon. Incorporated into the design was a subtle resemblance to Sean Connery. Surrounded by drawings and photographs of the actor for reference, sculptor Pete Konig works on a late version of the dragon model.

The final Draco maquette.

As Tippett wrestled with dragon designs and animatics, Steve Price, visual effects producer Judith Weaver and visual effects art director Mark Moore met repeatedly with Cohen to storyboard the dragon sequences. When a first go-around resulted in an estimated three hundred CG shots – a cost-prohibitive number – Cohen rethought the entire film and, with the storyboarding team, trimmed the count to a more manageable one hundred eighty. Subsequently, Price turned his attentions to supervising Jumanji, and ILM veteran Scott Squires was offered the supervisory role for Dragonheart. Although it meant leaving for Slovakia almost immediately, Squires could not resist the challenge of creating a photorealistic, fully emotive CG character who, with Dennis Quaid, would carry the entire film. Squires accepted the job in May, and within a week found himself in Eastern Europe.

Once approved, the extraordinarily complex design was turned over to Industrial Light & Magic, where it was translated into a computer model. Character animation supervisor James Straus and lead digital modeler Paul Giacoppo review the work in progress. ILM would ultimately produce nearly two hundred computer generated dragon shots for the show.

The only member of the ILM crew in Slovakia for the entire shoot, Squires spent the next five months – from July to November – supervising Vistavision plate photography. It was not an easy shoot. Since the movie was set almost entirely outdoors, the crew shot exteriors for 94 days of the 105-day schedule. In addition, because the dragon was such a prominently featured character, nearly every shot was a visual effects shot, requiring multiple cameras and physical effects gags to create the dragon's on-set interaction. Adding to the pressure was a tight production schedule that could not accommodate downtime due to finicky CG requirements. Plates had to be shot, and they had to be shot quickly. "We had to get quite a number of shots per day over there," Squires recalled, "and, of course, we shot the whole thing without motion control. But, all in all, the background plates proved to be very successful."

In part, that success was due to the extensive and detailed storyboards that had been devised, and to which Cohen and his camera crews adhered faithfully. A two-and-a-half-foot Draco model, provided by Tippett Studio, was instrumental in helping the director and crew visualize sequences. Before each Draco scene, the model would be positioned in front of the camera so that Cohen could determine how big he wanted the dragon to be in frame, and what the physical composition of the scene would be.

Another on-set aid was a state-of-the-art surveying system that enabled the visual effects crew to take accurate measurements over vast regions. "The locations were difficult because they were huge outdoor areas," Squires explained. "There were no flat planes to rely on, as there would be on an indoor set. So the accuracy of the measurements was critical – and it really paid off. The time it took to do the tracking was cut in half because we had accurate measurement data that could be plugged right into the computer."

Though Squires returned from Slovakia at the end of November, the computer animation would not begin officially until April, when Cohen would deliver a final edit of the live-action. The five-month delay provided an opportunity for the ILM team – including Squires, Weaver, character animation supervisor James Straus, visual effects preproduction co-supervisor Alex Seiden and digital effects supervisors Euan MacDonald and Kevin Rafferty – to construct the computer model and work out some of the more pressing aesthetic and technical issues. "Finding Draco was an evolving process for all of us," stated Squires. "We had the storyboards and the script and the live-action plates – but there was still an open palette as to which direction to go with the CG dragon. I felt that the hardest part of this job would be to convince the audience of the dragon's reality. They were going to be looking at something on the screen that they knew was not real, because dragons don't exist. My inclination was to keep him as physically-based as possible, downplaying his magical properties. We also knew we were going to have to light him well and have him really interact with the environment so that the audience would suspend its disbelief for an entire picture."

The first order of business was to translate Tippett's design into a workable computer model. Impressed by the artistry of the design, the digital team was also taken aback by its complexity. "The dragon model was so complicated and so highly detailed – with scales and spikes and all these things to make him interesting to look at – that to recreate it in the computer we had to go to a level of complexity never before achieved," James Straus commented. "The amount of data that had to be incorporated just to render one picture of the dragon was unbelievable. Draco was four times more detailed than the T-rex in Jurassic Park. There was as much data in Draco's head as in the entire T-rex. Since he was a major character, there were going to be tight closeups on him throughout the film – and he would have to hold up. It didn't leave us much room for doing computer tricks or shortcuts. We couldn't cheat at all."

Although maquettes supplied by Tippett were scanned in to provide a starting point, the model was ultimately built by hand, using Alias software. Four modelers – Paul Giacoppo, Paul Hunt, Bruce Buckley and Dan Taylor – were assigned to the task, each beginning at a different part of the dragon's body. "There were problems in getting all the different sections to join," noted Euan MacDonald. "It was difficult to coordinate so many people building one model. Ideally, it would have been done by one or two people – but we were under time constraints. Even with four people, it took a full five months to build this model."

An extended fight scene between Bowen and Draco skillfully intercut the computer generated dragon with a limited number of full-size props, built by the ILM creature shop.

The most complex of the props was a mechanized jaw and tongue rig, employed for shots of Bowen inside the dragon's mouth. Chief modelmaker Richard Miller and sculptor Mark Siegel carve foam for a mockup of the jaw.

Miller and Siegel sculpt a full-size dragon tail. Cast in fiberglass and filmed on location, the practical tail was replaced with a CG version during postproduction.

Among the model-building challenges was determining a wing structure that would allow for fluid extension and contraction – essentially, the same problem Tippett's team had encountered in the design phase. "Tippett's maquettes of the closed wing looked beautiful," stated Straus, "as did the open-wing maquettes. But we soon discovered they weren't really the same wing. We built the open wing on our computer model, then animated it to close – and it didn't look at all like the closed-wing sculpture. In other words, that open wing could not fold into the configuration of the closed wing. Basically, they had cheated the sculptures a little bit. We looked at the structure of this wing and realized that it was an impossible setup – but we had to make it work anyway." The computer graphics team solved the problem in the same manner the Tippett team had – by cheating. "We built a model of the open wing and a separate model of the closed wing, hoping we could find a way to ease one into the other." Fortunately, only a minimal number of wing transition shots were required. For those few shots, Euan MacDonald and his team devised a series of corrective shapes that could be animated to ease the transition from one wing to another.

While such technical issues were being addressed, digital artist Carolyn Rendu attended to the actual look of the model, recreating the coloring and textures in the Tippett sculpture with her digital paint tools. "I had the five-foot-long maquette to work from," Rendu recalled, "which was beautifully painted, with all the detail. My job was to bring that same detail to life on the CG model. We couldn't match it exactly in the virtual world, of course, because that is a world that only approximates reality. So we had to make certain adaptations, while keeping the spirit of the original model. I was primarily concerned with making him look beautiful and powerful."

Among the adjustments implemented as the sculpture was translated into the virtual world was the toning down of the iridescent sheen on the

A prop that did make it into the final cut was a full-size claw, featured in shots of Bowen pinned beneath the dragon's foot. Sculptors Howie Weed, Erik Jensen and Robert Cooper ready the claw for molding.

Off-camera manipulation of the spring-loaded claw proved sufficient to suggest the dragon's presence. The crew readies the device for a shot on location.

dragon's hide. "We retained a little of that," Straus said, "and it was written into the main shader for the dragon; but in most cases, you don't see it. The iridescence pulled the character too much out of reality and into fantasy. We had enough problems with all the different textures on this thing. We had horns, scales, a dozen different types of skin, each of which had its own reflective qualities, et cetera. The gold shimmer tended to complicate all of that, visually."

Once a first computer model was built, Straus went in and deleted superfluous points to simplify the animation process. Other revisions were made as the model neared completion. "We made some little modifications to make the dragon look as good as possible on the big screen," Squires remarked. "We ended up shortening the distance between Draco's eyes, and also changing the size and shape of the eyes a bit. We also eliminated the tiny feathers at the edge of the wings and large, thumb-like points on the wings – both of which interfered with the animation." Further refinements included decreasing the reptilian look of the face, and subtly increasing the creature's resemblance to Sean Connery.

To make the full-size jaw and tongue as responsive as possible, the creature crew equipped the rig with sophisticated hydraulics, operated via joystick controllers by a four-person puppeteering team. Eben Stromquist – charged with mechanizing the tongue to extend, curl up and twist left or right – tests the articulation mechanism.

While the dragon model was being perfected, software was being written to meet character-specific animation demands. Of particular concern was the exacting animation required for precise lip-sync and facial expression – animation too refined and detailed to be executed in Softimage, the standard animation software employed by ILM. Early on, motion capture techniques were considered. "Some motion capture had been used on Casper," Alex Seiden stated, "but we decided that we didn't want any part of it. Motion capture is difficult to control, and it often doesn't look good. For those reasons, we decided we would have to come up with something else for the lip-sync and facial animation. At that time, there was no tool that could do what we needed this dragon to do."

On location, the seven-foot-tall rig was attached to a support structure supplied by practical effects supervisor Kit West. Dennis Quaid was harnessed into place and lifted fourteen feet for filming of the mouth interior scenes. In postproduction, the jaw was surrounded by a digital dragon head. Ping-pong balls cut in half were attached to the rig to aid in the tracking of the CG head.

Software designer Cary Phillips, a recent hiree, was eager to tackle the problem. "Cary had a lot of energy and enthusiasm," Straus recalled. "We told him what we wanted and he insisted he could do it. I'd just shake my head and say, 'I don't know…'" Despite their skepticism, Straus and Seiden roughed out a format for a lip-sync and facial animation program, then turned the problem over to Phillips. "Cary got this software up and running, and we continued to refine it. It was called Caricature – Cari, for short – and it was phenomenal. I'd never seen anything like it. It allowed us to build up very complex movements by combining a number of different shapes. With Cari, we could do the broad expressions; but then, on top of that, we could go in and get all these tiny little movements, all over the face. It was so fast and interactive, we ended up using it for more than the lip-sync. We could use it to touch up animation on the body. We could use it as a viewer for all the little details, such as wrinkles and muscle movements."

Neither Bowen nor Draco can vanquish the other without also destroying himself.

While Cari was utilized for lip-sync and facial articulation, Softimage was still employed to animate the dragon's gross movements. "Softimage gave us the basic positions and broad movements," Straus affirmed. "It is the most interactive 3-D animation software available; but because of the complexity of the dragon model, we had to bring the speed of Softimage down to a crawl. With Softimage, if we made an adjustment to the animation, we'd have to wait a while to see it. In Cari, we could make the adjustment and see it right away. That made a tremendous difference."

Another advantage to Cari over Softimage was that the animator could work with a shaded model, as opposed to a wireframe. "We could set whatever level of detail we wanted as we were animating

– everything from full resolution to a rough approximation," explained Straus. "We would do the broad motion with the wire-frame in Softimage, then bring it into Cari, all shaded, to do the refinements. That made a huge difference in the animation. It takes a lot of experience to know what you are looking at when you're animating a wire-frame. After a while, all the lines start to blur together. Being able to animate with a fully shaded model was just incredible – the next step in this technology. We'd been able to do that before with simple models, but not with anything as complex as Draco. The software continued to evolve as the show went on – it just kept getting better and better. Cari was the big technical breakthrough on Dragonheart."

Armed with the exciting new software, the animators were still faced with the daunting task of producing extraordinarily subtle animation that would incorporate Sean Connery's expressions and mannerisms. To guide the animators, Cohen had assembled an extensive library of the actor's varied film performances. "The library gave us nice references of Connery when he was angry or flirting or whatever," said Straus. "We were able to pick up subtle character traits from those images, which was very helpful. Subtle moments, when there isn't much discernible action, are the hardest things to animate. Broad action requires more actual work – but at least you know what's going to happen. The subtle moments are like being presented with a blank piece of paper – what am I going to put there? When the dragon is talking for extended lengths of time, or just lying there listening, what do you have him do? Linda Bel and Chris Armstrong did a wonderful job on those types of shots – some of the most extended, subtle character animation I've ever seen. Watching that stuff, there are moments that make me want to cry. He's just alive."

Guidance was also provided by Cohen, who visited the facility on several occasions, videotaping his instructions and performance suggestions so that the animators could refer to the tapes after the director was gone. "Rob had a really good sense of how he wanted this character to play," Straus related. "He didn't just want a plodding type of monster, the kind of dumb animal we had done before. He wanted a very agile, dynamic, quick and graceful creature. But at the same time, he had to be true to the Connery persona – powerful and confident. Rob did not want us to feel restricted in our animation by this immense body. He also wanted to go all the way in terms of the facial expressions and the body language. He wanted us to draw on all the strengths of Sean Connery's vocal performance. The most important thing he stressed to us was that this dragon had to have a soul. We could occasionally go into the comedy realm with the character – but, throughout, there had to be a center of dignity."

By the end of March, the model had been completed, many of the animation concerns had been addressed, and ILM was ready to jump into full-blown production. Before the computer animation assignment could begin in earnest, however, a test shot had to be put together and presented to de Laurentiis and Cohen for approval. "We wanted to have something to show them," stated Squires, "and we wanted a chance to work out some of the problems. For the test, we chose a shot of Draco at a waterfall – for a variety of reasons. It involved a background plate that didn't have any people in it, so there was no worry about whether that particular take would be used. We also chose it because it was in daylight – a worst-case scenario in terms of lighting. We wanted to work that problem out, right from the beginning."

Weary of the hours-long standoff, Bowen and Draco decide to resolve the conflict by joining forces. To dupe peasants into paying for the services of a dragonslayer, Draco launches a series of mock attacks on the countryside. A microlight aircraft was often used during the live-action shoot to help actors and extras on the ground follow the maneuvers of the airborne beast.

Draco strikes a threatening pose atop a rocky perch. Fire-breathing shots incorporated practical fire elements, shot separately then tracked to the CG dragon.

As always, the technical directors were charged with finessing the lighting on the CG character. “Lighting was one of our biggest worries,” recalled Straus. “To see Draco large in frame, in daylight, was incredibly hard. But we knew the TDs would do an excellent job on the lighting. When Draco is fully lit, he is astounding.” Cohen’s aesthetic decision to present Draco almost exclusively in bright daylight also meant that there would be an unusually large number of shadows. “To meet the demand,” explained Euan MacDonald, “Ben Snow enhanced a technique that ILM had developed for a previous project, called Y-cast shadows, in which the shadow density varies depending on the dragon’s distance from the ground. Obviously, the farther away he is, the less dense the shadow would be.” Rather than create shadows as 2-D images, the 3-D dragon model was used to actually cast shadows. “Everyone was very accustomed to working with the 3-D model, so it was easier for us to cast shadows with that than it would have been to fake a shadow.”

After a successful scam, Bowen finds Draco swimming in a lake. Reflections and interaction with the water were among the challenges addressed by the digital team.

Even after the lighting was worked out, a lot of tweaking was required to blend the dragon into the background plates. “We developed some post-render techniques, such as Lightwrap, that we could use in the composite stage,” stated MacDonald. “Lightwrap gave the model a light halo effect; so instead of Draco’s having a very hard edge, he blended with the background plate. In some cases, we would diffuse the background to get an ambient feel. That saved us from having to do more extensive light work. It was quick and dirty, but effective.”

One of the problems that plagued the TDs throughout much of the production was creating a shader that would make the dragon’s eyes look real and expressive. “No matter how much expression we got on the face,” Straus observed, “if the eyes weren’t right, it wouldn’t look right. Once we got the lip-sync down, and once the audience was accustomed to that, they were going to stop looking at the talking and start looking right into Draco’s eyes – the soul of the character. They had to look real and wet, as if they had depth.”

“The eyes were an ongoing concern,” MacDonald concurred. “They changed a lot throughout production, mainly in terms of texture and reflectivity. Finally, Barry Armour wrote a shader that was based on one used in Casper. It gave us control over different parts of the eye; and it allowed us to do a lot with reflections and highlights.” For an added touch of realism, the eyes were often animated to dilate like a cat’s eye.

The approval of the waterfall test shot, and Cohen’s delivery of the final cut of the film, paved the way for ILM’s year-long computer animation assignment. “Having the film already cut was a huge advantage for us,” commented Seiden. “It gave us a chance to look over the entire movie and make

decisions about what things would be best to start first and how we would approach each piece. We knew that the shot list wasn't going to grow like it usually does, so we had a really good idea of what the difficulties were going to be and how to pace ourselves. This was definitely the most straightforward and economical way to do this movie. We had a lot of lead time on this project – and we made the most of it."

To facilitate the creative collaboration between ILM and Rob Cohen, a fiber optic hookup was established. "We couldn't have done the film without that," Squires commented. "Rob was in Rome throughout most of our year-long production – working on his next film, Daylight – so we had these satellite links with him twice a week. Because of the time difference, the link-ups would happen at the end of Rob's work day. For months, he would spend all day shooting Daylight, then deal with Dragonheart at night. It was admirable, the way he was able to change hats. But Dragonheart was still very much in his heart and Raffaella's heart. They never seemed to mind talking about this movie." The fiber optic connection allowed Cohen to review video of all the in-progress shots. "We had thirty to forty shots at various stages of completion at any one time, so there was always a lot to show him." Live feeds were replaced by videotapes and telephone conversations when Cohen completed his overseas shoot and began work in New York.

Dragonheart begins with a scene in which a knight, Bowen, spars with his pupil, Prince Einon (Lee Oakes), while teaching the boy the tenets of the old code. Bowen is ignorant of the boy's inherent wickedness – amply illustrated when the youth eagerly joins his father in decimating a nearby peasant village. When Einon is mortally wounded, Bowen returns the boy to his mother, Queen Aislinn (Julie Christie). For an establishing shot of Einon's home – a fortress-like castle made of wood – effects coordinator John Swallow commissioned a digital matte painting from Illusion Arts. "I actually began by doing a traditional matte painting," remarked company co-founder Syd Dutton. "I think, in most cases, final matte shots have more of an emotional punch if they start as real art work. I painted what is called a 'motte and bailey' – a wooden stockade that was the earliest type of castle built in Europe. That design appealed to Rob because of its historical authenticity and because it is an image that has never been seen in a motion picture, to my knowledge. That painting was then scanned into the computer." Digital artist Robert Stromberg took over from there, refining the painting with animated details such as waving flags, clouds and a moving stream in the foreground. Flying birds were animated by Fumi Mashimo. David Williams composited the painting with a live-action plate featuring a lush landscape and a horse and rider in the distance.

Realizing that only a dragon's magic will save the boy, Aislinn transports Einon to Draco's volcanic lair. In response to the queen's plea, the generous creature opens his own chest and infuses Einon with half of his heart of liquid fire. Backgrounds for the scene were shot in a cave set built by production designer Benjamin Fernandez. The volcanic environment was simulated with backlit, gelled pits of roiling methocel, rigged by special effects supervisor Kit West. In postproduction, ILM inserted the shadowy figure of Draco. "Rob wanted to hide Draco in that first scene," said Squires, "so he is in silhouette. We do see a little glint in his eyes and a bit of texture on his face and body – but not enough so that you can make out any detail. It was basically just a tease for the eventual big reveal of Draco."

Draco assists Bowen in starting a fire as they set up camp. Kit West orchestrated dozens of large- and small-scale pyrotechnic gags in the course of the five-month-long shoot.

When a village offers a peasant girl as a sacrifice to the dragon, Draco scoops up the young woman and transports her to a waterfall. Staged in bright daylight – and with difficult aspects such as water interaction to address – the waterfall scene was chosen early on as an ideal test sequence. In the course of completing the test, the digital team worked out lighting issues and developed new animation software. Subsequently named Caricature, the animation program was both faster and more interactive than previous systems, and also enabled the animators to work with a shaded form, rather than a wire-frame.

The scene also featured a digital transition from a prosthetic wound piece worn by Oakes to the actor's unscarred chest as the boy's injury is healed. Interactive illumination on the actors' faces was achieved on location with a special light rig moved through the scene. "That lighting interaction had to be finessed in post," noted Squires. "Some of it was a little too hard on the faces and looked a bit too much like what it was – a light rig being moved through the set. We went in and corrected that, softening the glow on the faces and adding a little glow to the edge of frame to tie it all in." The light emanating from Draco's heart was entirely computer generated.

Draco flirts with Kara (Dina Meyer) at the waterfall. On the location set, 'monster sticks' – long poles with tennis ball 'eyes' attached – stood in for the CG character to guide the actors' eyelines.

Soon after Einon's miraculous healing – and his subsequent ascent to the throne – the boy's true character is revealed to Bowen. Convinced that it is the dragon's heart that has ruined the lad, Bowen takes his leave of the new king, vowing to eradicate dragons from the face of the earth.

The story picks up twelve years later. The once idealistic Bowen is now a cynical mercenary who kills dragons for money as much as for vengeance. His personal vendetta against the beasts is illustrated when the embittered knight hunts the Old Scarred One – an aged dragon seen only as a shadow passing over the dragonslayer and Brother Gilbert (Pete Postlethwaite), the monk who has joined him. On location, the production team used a microlight aircraft to stand in for the dragon and to assist the actors in visualizing the nonexistent creature. "The microlight was great for eyelines," stated Squires. "It was especially helpful in big scenes, where we had a lot of extras that had to follow the flight path of the dragon with their eyes. It also gave us very broad strokes, in terms of telling us the position of the dragon. In post, the microlight was removed from the background plate and replaced by our dragon." The microlight – with a Vistavision camera mounted to its nose – was also employed to capture aerial plates representing Draco's point of view.

After the knight's slaughter of the Old Scarred One – played entirely off-camera – Gilbert reunites with Bowen at a waterfall. The waterfall and adjacent cave were carved out of foam by the art department, while Kit West engineered pumps to carry millions of gallons of water over the falls, into a pond below and back up to the top. In the waterfall scene, Gilbert – an amateur scribe – sits upon a rock to pen an homage to Bowen. Suddenly, the 'rock' opens an eye and begins to move. Gilbert is tossed from his seat; and, in the next cut, a dragon's tail is seen retreating to the cave behind the falls.

On location, Postlethwaite had been positioned on a rocklike rig that rose to simulate the dragon's initial movement and topple the actor from his perch. The original plan was to cut directly to this practical rig from a CG shot of the dragon's eye opening. "Rob thought the practical rig would suffice for the second part of the shot," Squires explained, "but when he saw it cut together with the previous CG shot, it was clear that the practical rig wasn't really sufficient. So we replaced the

practical rig with a CG Draco head." The look of that head – and the way in which it would blend into the surrounding rock – was not immediately clear to the CG team. "The shot of the stone dragon was always a bit vague, conceptually. Was he actually encrusted in the rocks? Was he supposed to change shape and form? Those issues hadn't been fully hammered out when we started the shot, so it took some careful thinking and planning to get it." Technical director Barry Armour came up with a subtle approach that consisted of slight texture and color changes as the dragon's eye opens.

The final shot of the dragon's tail retreating into the cave was also computer generated. To capture water interaction on the set, a cone-shaped tail was mounted onto a dolly stationed behind the falls. The metal cone was dollied in and out of the falling water in the background plate, then replaced with the CG tail in post.

Baited by Bowen, Draco suddenly bursts out from behind the falls and takes flight – the first full reveal of the dragon. "It's a great entrance," Squires commented. "Kit West had done some mortar effects to suggest him bursting out of the water. To enhance those, we shot additional water elements that were composited into the shots by Erik Mattson. He did a terrific job of matching in all those elements, adding the interaction of Draco's feet touching the water just before he takes off."

After bursting from the cave, the dragon flies right over camera. "The flying shots were a major technical difficulty," noted Straus. "The wings were huge, with a membrane that had to move with some controllability and realism. It was very difficult – especially when he had to carry on a dialogue and fly at the same time." The animation was made even more difficult when Rob Cohen announced that he wanted no gliding in the flying shots. "I had thought there would be three or four good, powerful, slow pumps of the wings, and then he would be gliding the rest of the time. But Rob said, 'No, my dragon is muscly and is always moving.' He wanted Draco to be very active while he was flying – always pumping and thrusting with his wings. Rob sent us hilarious videos of himself acting out the flying. He'd be pumping his arms, yelling: 'Like this! Like this! Like you're on the Nautilus machine!' We kept pumping up the animation to meet his requirements, and we ended up with a very active flying motion." Animators began with one of three basic flying cycles created by Dennis Turner, then tweaked the animation to meet the demands of each specific shot.

In pursuit, Bowen fires a bolo that wraps around the airborne dragon's foot. Consequently, he is yanked off his feet and flown through the forest, bumping into trees and kicking up dust all the way. Set up in a Slovakian national forest, the sequence was assigned to Kit West's team. Dennis Quaid was fitted with a harness and flown either from a crane or between two forty-foot towers. Rigs and wires were digitally removed from the shots, then replaced with a CG rope running from Bowen's bolo to the dragon's foot.

When Bowen finally succeeds in bringing the dragon down, an extended fight scene ensues. Quaid was required to perform a series of precisely choreographed fight moves, without benefit of his adversary's presence in the scene. The dragon's movements around the location were suggested

with small mortar explosions of dust and debris, rigged by West's crew. Other interactive effects included a log rigged to move as if the dragon's tail were caught beneath it. "We'd done some practical things with the log on location," Squires recalled, "but most of those shots were replaced with a CG log so that we could have more control and make it move more in tandem with the dragon. In general, practical effects don't give us the level of control we need for these kinds of shots. Still, it is best to start with some kind of practical interaction on location. Typically, we would shoot one plate with the practical effect, and then a clean plate – so we'd have an option as to which one we wanted to use. If nothing else, interactive effects provided us with good reference material."

For an epic, climactic battle – the legendary Bowen's attempt to kill Draco – the production art department built a full-scale dragon head and a full-size dragon claw. Illusion Arts sculptor Adam Howard poses with the head, which was built by the production art department. The claw was built by the creature shop crew.

Aramesh Khashayar of Illusion Arts prepares to paint a section of the dragon's head. Illusion Arts specialized in painting the dragon's skin for the Arthurian epic.

Fantasy II's Jeff Olson and Jeff Campbell pose with the dragon's head. Fantasy II was responsible for the interior and exterior castle sets.

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Fantasy II's Jeff Olson and Jeff Campbell pose with the dragon's head. Fantasy II was responsible for the interior and exterior castle sets. Waves crashing against the shore were computer animated.

Practical support for the fight scene was also provided by a full-size dragon claw built by the ILM creature shop and used for a shot of Draco pinning Bowen beneath his oversize foot. Originally, the plan had been to use a fully animatronic claw to achieve a ripping and clawing action; but by the time it was implemented, the claw had been simplified to a posable version. "The claw had some action," stated department manager Jeff Olson, "but it wasn't fully articulated. The skin flexed on it and the wrist and forearm were spring-loaded so the set crew could get a good look out of it just by physically moving it. There was a system of counterweights; and by moving those, the spring-loaded joints appeared to move. It was actually very lifelike."

Although full-sized dragon heads were built by the production art department, such pieces were used only for reference purposes due to Squires' and Cohen's mutual conviction that they would not intercut well with sophisticated CG shots. As a result, the foam latex claw was among the very few full-size props to actually make it into the final film. "Fortunately," Squires commented, "the claw is seen only at night, so it held up pretty well. Our shop had also built a full-size fiberglass tail for a shot of the dragon hitting Bowen in the chest. We shot that with the fiberglass tail and without – and we ended up replacing it with a CG tail. That shot was in daylight and the prop just didn't look good enough in that light. We didn't shoot too many full-size props to begin with, but the ones shot in daylight were all replaced with CG."

For the computer animators, the fight scene presented a key problem – determining the dragon's weight. Cohen had envisioned a lightweight, nimble creature made of starlight and fire – characteristics that did not always jibe with convincing animation. "Draco's size and mass dictated a certain kind of slow movement," Squires said, "but it is hard to get an interesting character out of something that is lumbering around. As it turned out, we had to determine his weight shot by shot. His weight varies, depending on his actions and his interactions with people and the environment."

Eventually, the long fight between dragon and knight deteriorates into a prolonged standoff, with Bowen crouched inside Draco's gaping mouth, his sword pointed at the dragon's soft palate. From the beginning of the production, the intent had been to build a full-scale mechanical rig to represent the interior of the dragon's mouth, then surround that rig with the CG dragon head. To determine the scale of the full-size jaw, Olson and the creature shop crew drew the head on paper and blew up the image. "We projected the drawing from an overhead projector, scaling it up," Olson described. "Then we had Richard Miller, one of our sculptors who is roughly the size of Dennis

Quaid, crouch down in front of it so we could draw around him and study the size relationships." Several drawings were sent to Rob Cohen and Raffaella de Laurentiis before one was approved. "When we finally had it, we built a three-dimensional mockup out of foam and plywood to insure that there would be room for Dennis Quaid and cameras inside."

"With the mockup," creature shop supervisor Jean Bolte explained, "Rob could see exactly what he was going to get and where he could put his cameras. He asked if we could take the top of the mouth off so he could work from that angle as well; and we did that – the top was like a convertible car roof that popped off, making for easier camera access. The sides of the mouth could also be taken apart and reassembled as needed. Rob was able to really clarify what he wanted from the rig; and by the time we got to actually building the mouth, we knew exactly what his requirements were."

Once the mockup was approved, the creature shop turned to mechanical matters, with Mike Steffe taking the lead in engineering the main operations of the jaw and Eben Stromquist working on the tongue movement. "The jaws were cantilevered out quite a bit, supported by two hydraulic pistons," related Stromquist, "and only closed about six to ten inches. That was partly for safety – we didn't want to crush Dennis Quaid inside this thing." The tongue movement was far more complex, and its mechanizing took up most of the creature shop's time on the project. "The tongue was very important in the scene," said Olson. "The script called for gagging and for the speaking of a number of lines. It was quite a challenge. The mechanism we finally came up with allowed the tongue to ride forward, shift in and out of the mouth, as well as curl, twist and flatten out."

Originally, the crew had hoped to mechanize the tongue with pneumatic controls. But when that approach proved slow and unresponsive, the engineers switched to hydraulic cylinders and linear potentiometers. Because hydraulics was a new area for the creature shop team, Bob Kiefer of Hydraulic Controls was brought in for consultation. "Bob helped us develop the hydraulics and the pumps necessary to do all this," stated Stromquist. "It was an expensive option; but considering what we got out of it, it was well worth the cost." To mechanize the tongue, Stromquist translated cross sections into concentric plates fitted with cables. "Manipulating any one of four cables would pull the tongue and make it twist left or right. On top of that, the tip of the tongue had a four-way axis, controlled by servo hydraulics. Underneath were actuators that drove the tongue forward and lifted it up. Finally, there were tripod hydraulics – three long, skinny pistons that controlled the base of the tongue. As the tripod moved forward, the whole tongue moved out a good foot or more. Between the tripod movement in the base, the movement at the tip and this forward movement, the tongue really had a wide range of articulation."

Puppeteers maneuvered most of the tongue and jaw mechanisms with standard joystick controls. The tripod rig, however, was operated via a special controller made up of linear potentiometers. "It was like a waldo," noted Stromquist, "basically a duplicate configuration of the hydraulics. We had a triangle of hydraulics, and a triangle of controls to move it with."

Made of hard-cast plastic and urethane, and held together with an aluminum frame, the finished rig was seven feet long, seven feet tall and four feet wide, and weighed about twelve hundred pounds. A cantilevered structure to support the rig and provide additional up-and-down movement was built by Kit West's physical effects crew. Once mounted on the support rig, the mechanical jaw

reached a height of approximately fourteen feet. The jaw was operated by four puppeteers from the ILM creature shop, positioned on the ground where they could monitor the movements through a video tap. To accommodate the live-action, the rig had been equipped with accumulator tanks so that the sound of the motors would not interfere with production sound. “The accumulator tanks allowed us to operate for two minutes at a time without having to turn the motors back on,” explained Olson. “That was enough to get them through most of their shots.”

In postproduction, the digital crew was assigned the task of surrounding the mechanical rig with a computer generated dragon head. Ping-pong balls cut in half had been positioned along the jaw to simplify the tracking process. “We ended up rebuilding the CG head to get it to match the jaw rig better,” stated Squires. “We’d had to cheat the scale of the practical jaw a little to get Dennis Quaid to fit inside; so we had to manipulate the CG head a bit, as well.”

“Initially,” added Euan MacDonald, “we were doing standard match-moving techniques. But the job turned out to be much more complicated. Doug Smith supervised extensive facial animation just to get the head to fit and to get correct mannerisms and lip-sync. We also had to put a back end on Draco to accommodate certain camera angles.”

Not only did the team have to concern itself with matching the practical tongue with the CG head, they also had to match the real actor with a CG replacement in a shot of Draco scooping Bowen into his mouth. “That was all a CG Bowen and a CG Draco,” Squires explained. “Then we cut to a closeup of the real Bowen in the jaw rig, surrounded by the CG head. We had to be careful that all of those mix-and-match shots intercut well, without detection.” Although not anticipated, digital actors were used sporadically throughout the film. “We had planned on using a CG Bowen for that one pickup shot; but we wound up using him in more shots, such as one in which Bowen is pinned under Draco’s claw. We didn’t know, in the beginning, how well that would work. There was so much texture in Bowen’s clothing that we had to match, and we had to actually animate him – it wasn’t just legs kicking, à la the CG lawyer in Jurassic Park. There was a lot of movement in the character.” The digital actor was modeled by Wayne Kennedy, then painted by Jean-Claude Langer and animated by Chris Armstrong.

Recognizing that the standoff can only end badly, Bowen and Draco agree to work together, with the dragon threatening villages and Bowen collecting fees to ‘slay’ the menace. Using a catapult device, Bowen shoots an arrow at the dragon, who catches the projectile in his wing and proceeds to fake his own death. The new partners first try out their scam at Felton’s mill – a set consisting of a castle under construction, grain fields and 10th-century style mills. Draco’s fireball assault on the settlement was simulated by the physical effects team, which pumped gasoline through a quarter-mile of pipe to produce a napalm-like fire run. An excess of firepower resulted in smoke and flames engulfing the upper parts of the frame where Draco would have to be inserted, complicating the compositing of the character. To simulate the swirling disruption of Draco’s wings moving through the smoke, the microlight airplane was flown repeatedly through the smoky clouds. “Out of all those takes,” noted Squires, “only one created a little bit of a smoke curl on the wing as it flew through. We used that shot as a reference, then animated our own smoke swirl to interact as Draco flew by. We also created some interaction with the fire, digitally manipulating the flames.”

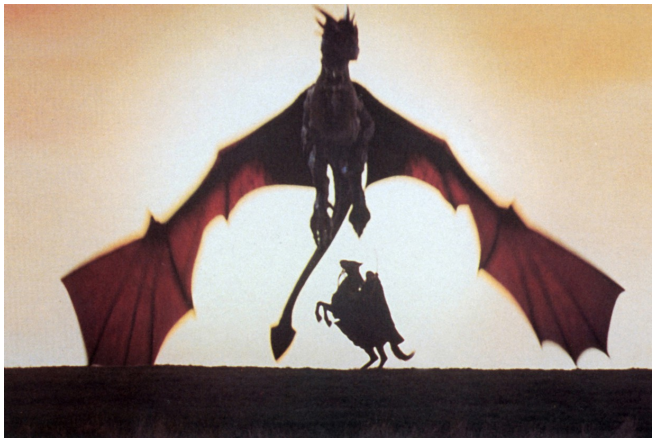
To match the fiery assault filmed on location, the digital team tracked fireballs spewing from the dragon's nostrils. "In most cases," commented MacDonald, "fireballs were rendered digital elements made up of a number of different layers. Other times, we'd take practical flame elements and composite those in. The technique we used just depended on the kind of flame the shot required."

Having successfully perpetrated the scam, Bowen later meets up with Draco, finding the dragon swimming in a lake. Shooting background plates for the sequence – which had to include movement in the water to suggest Draco's presence – had been troublesome. "We tried shooting from a boat," stated Squires, "followed by a rig the mechanical effects crew set up so that we could get a bit of a ripple in the water, with bubbles rising. We ended up shooting from a ferry, with a large boom arm moving across the lake. We decided to add the interaction in post, and not bother with any kind of practical rig. Fortunately, Draco was supposed to be far enough down in the water not to create additional turbulence on the surface."

Long after a suitable background plate was filmed, the digital crew was faced with the bigger task of conceptualizing the dragon's movements in the fluid environment. "Having Draco underwater, swimming, was one of those images that, even if well executed, could have looked bad," noted Squires. "And there were a lot of questions – how deep is he supposed to be in the water? Is this a clear lake or a muddy lake? We had to put Draco in the water, maintaining the appropriate reflections and water distortion throughout the scene. Also, the parts of the dragon's body that were supposed to be in deeper water had to be dissipated so that they couldn't be seen as clearly. It was a very difficult sequence."

Draco extends a wing over Bowen to shield him from the rain. Water cascading down the computer generated wing was simulated with shaders, employed in conjunction with practical water elements.

Following the swimming exhibition, Draco pops up out of the lake, water dripping from his head. On location, the film crew had shot footage of a full-size head emerging from the water to capture water drops and highlights that could, hopefully, be transplanted to the CG dragon. In the end, however, dripping water and highlights were created with shaders written by Euan MacDonald, and the prop footage was used merely for reference. "I initially used existing shaders that had been developed for Jurassic Park," MacDonald commented, "but I ended up rewriting them. The shader from Jurassic was just for simple rain, and was only meant to be used in night shots. This show had water shots that had to hold up in daylight." In some cases, practical water elements filmed on location or at ILM were layered



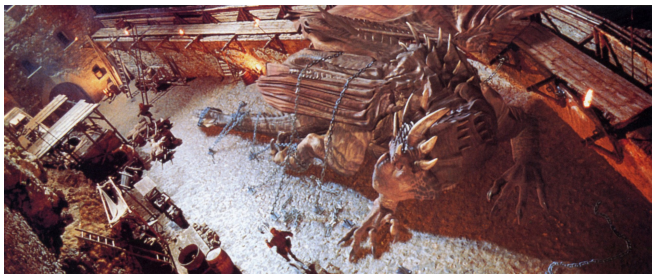
After an epiphany at Avalon, Bowen and Draco return to Kara's village to organize a peasant army. Their return is signaled when Bowen appears on a hilltop, with Draco rising behind him in silhouette. Different versions of the wings were required for in-flight scenes and for scenes of them folded at rest. Veins and other textures were

in to suggest water dripping off of the computer generated dragon.

painstakingly painted onto the translucent open wings by digital artist Carolyn Rendu.

After Felton's mill, Bowen is seen riding through grasslands, with Draco circling overhead. The scene went through a major conceptual change from storyboarding to final shot. "Originally," Squires said, "Rob wanted us to see the dragon flying upside down as he circled Bowen – as if he was made of starlight. One of the dichotomies of this character was that sometimes he was heavy, falling down and causing all of this debris to fly up; but other times – such as in this scene – he was supposed to be light as air, flying on his back right next to Bowen, almost backstroking in the air. When Rob first brought up the idea, Phil Tippett said, 'That's not going to work.' Then Steve Price said, 'That's not going to work.' And finally, I said, 'That's not going to work.' And once Rob had the film cut and saw how the other shots were progressing, he realized that it was not going to work. We had to establish some rules of consistency for the creature. He couldn't be big and lumbering in one scene, and floating in the next."

Draco eventually lands in the grass to walk beside Bowen. During plate photography, several attempts were made to create dragon-size footprints and tail imprints in the grass with toboggan-like rigs devised by Kit West. At one point, someone suggested that it would be more expedient to have crew members simply lie in the grass and move their arms and legs to create 'snow' angels. Although effective, the technique did not ultimately suffice – largely because the grass was unusually tough and disinclined to lie flat. "We ended up having to do quite a bit of post work to get it to look as if the dragon was walking through the grass and pushing it down," recalled Squires. "The little 'grass angels' just didn't cut it – although, at the time, it was great fun to watch the crew in the grass. In the end, we either animated what was there or we took bits and pieces of other elements that we shot. We had shots of the grass being blown by fans; and bits and pieces of that could be cut together and manipulated. In other cases, we had a guy walking through with a black cart, which made the grass flip down – so we could take pieces of that, as well. We just had to create the interaction by piecing it together, bit by bit."



An attack on Einon's castle results in Draco's capture. For scenes of him fettered in the courtyard, lengths of chain were mounted on pipes and manipulated to suggest the dragon's movement. When it was later decided that the chains needed to be larger and more substantial, the real links were replaced with computer generated substitutes, painstakingly animated.

The unlikely partners in crime settle in for the night around a campfire. Close interaction between the two in the intimate campfire scene required extensive rotoscoping, supervised by Sandy Houston and executed by Kevin Barnhill and Joanne Hafner. "There were some great shots where Draco gets right up to Bowen's face," Squires commented. "Since we didn't shoot any bluescreen, we had to do a lot of rotoscoping for those. In some cases, the rotoscoping was severely complicated by Dennis' hair – he had this long, blonde ponytail blowing around. Our roto department came through with flying colors."

On location, the dragon's placement in the courtyard was marked with full-size head and tail props.

Draco and Bowen next try their scam at a little village that is home to Kara (Dina Meyer), a spirited peasant woman intent on rebellion. "One of the challenges of the Kara's village sequence was that the background plates varied considerably," Squires recalled. "Some days were overcast and some were sunny, so we had to do a lot of work to make all the skies match. In a number of cases, we put in a whole new sky. It was particularly difficult to get shots of Draco breathing fire to read well in daylight shots, against a bald sky. We really had to punch up the fire elements to make them read."

In the picture's closing moments, Draco nobly sacrifices his own life – taking an ax in the chest – so that Einon might also be destroyed.

"Throughout the first fight and Kara's village sequences," Kevin Rafferty affirmed, "sky replacement or enhancement became a great concern. We were riding a double-edged sword. Our first priority was to match the lighting in the plate. We would then check the surrounding shots for sky continuity and Draco continuity. At that point, we had to make the decision to change the sky, Draco or both."

Rather than pay the dragonslayer's price, the peasants offer up Kara as a sacrifice to the dragon, tying her to a cart. Draco scoops her up, cart and all, and transports her to the waterfall. Though originally conceived as a split-screen composite – with live-action elements of Dina Meyer split into footage of the cart being lifted by a crane – Squires later opted to insert a digital Kara into the scene, instead. "We had shot that practically," Squires stated, "but the motion and speed weren't quite right. So we created a CG cart and we switched to a CG Kara for part of that sequence. It was tricky because we were going from live-action to a fully CG character – and it wasn't a nighttime shot and it wasn't a super-short take."

Throughout much of the subsequent scene between Kara and Draco at the waterfall, the dragon stands in the pond. On location, the effects team had photographed black props in the pond to capture the appropriate interaction of the water lapping against Draco's legs. Unfortunately, the resulting imagery was ineffective. In the end, the CG team 'stole' more dramatic water ripples from a nearby rock, piecing those elements into the area around Draco's legs to create the interaction.

A final scam at a swamp village goes awry when Draco performs his death plunge into a too shallow body of water. Temporarily stuck in the mud, Draco is discovered by the angry villagers, who proceed to advance on both the dragon and the knight. As storyboarded, Draco's plunge into the swamp was to be accompanied by trees being knocked down – a practical effect that was attempted during the original location shoot, with lightweight mock trees rigged on springs to collapse on cue. In addition, Draco's body dropping into the water was simulated with weights dropped from a helicopter. Ultimately, the background plates were judged unsuitable because the trees did not fall with an appropriate sense of weight, and the helicopter, struggling with windy conditions, repeatedly missed its weight-dropping marks.

Months after production wrapped, Squires and a small crew returned to the site for a reshoot. Heavier trees were rigged to topple by Kit West and his crew, and weights were dropped by crane, rather than helicopter, for more controllability. "They'd only scheduled a day for the reshoot," Squires recalled. "We went ahead and shot the day we got there, our test day, which was a good thing because it rained the next day." The new footage of trees falling was married to practical splash elements. "We used a log and barrels and other things to create splashes and ripples. Mike Bauer blended and tweaked all of those different elements until the shot looked good."

The shaders developed by Euan MacDonald created the look of water and mud covering the dragon. "Those water shots were very difficult," said MacDonald. "Some had as many as twenty-five different elements in them. We also had to play with the background plate a lot, disturbing the water to make it look as if the dragon was really in there, causing ripples. We produced ripples and other water interaction, such as splashes and foam, which helped to blend him into the water. Again, we employed compositing techniques and in-house software to reposition things, rescale things, stretch things. Those swamp shots were some of the most complex, and took the most time to do, because Draco is very big in the frame, sitting in broad daylight."

In the following shot, Draco rises from the swamp and runs past the advancing mob of villagers. "Because it was such a long dolly shot," stated Squires, "it was rotoscope hell. There were peasants, huts, fish hanging on strings, all kinds of things in the foreground, with Draco in the background." As the angry villagers advance on Kara, Bowen and Gilbert on horseback, Draco swoops down to rescue the trio – horse and all – and proceeds to the safety of Avalon, the legendary castle and burial place of King Arthur and his knights. Shots of Draco and his charges in flight were achieved by compositing CG models of the horse and all three actors into aerial plates shot from the microlight. "The original plan was to fly through clouds, which, at the last minute, would open up to reveal the castle below. We had all of these POV shots, flying in towards a real castle – but Rob decided to make it much more elaborate, with mist around the castle, and the castle itself on an island."

The redesigned shot was turned over to Illusion Arts, where Syd Dutton rendered a conceptual illustration of a castle set off the coast, shrouded in clouds and surrounded by ocean. "Because

there was such a buildup to Avalon throughout the film," Dutton said, "it was very important to Rob Cohen that when the castle was finally revealed, it be something really spectacular – a very mythical place." Starting from scratch, the Illusion Arts team first attempted a traditional approach, conducting multiplane tests with their motion control matte camera. When it became obvious that the traditional approach would not suffice, Illusion Arts commissioned Spacecam to capture aerial plates over rugged areas of Catalina Island. "The plate had the surrounding ocean, with cliffs in the foreground, and that became the bones of the shot."

Added to the plate photography was a digital matte painting – by Robert Stromberg and Mike Wassel – that included the island, the castle, sky and sea birds, a sunrise and additional ocean imagery, with animated waves crashing upon the shoreline. For a final element of mist surrounding the castle, Illusion Arts turned to Hammerhead, a digital effects company founded by some of the senior artists and technicians from the now-shuttered Southern California branch of Pacific Data Images. There, Rebecca Marie and Thad Beier created cloud and mist elements. All of the elements were composited and tracked by digital supervisors Richard Patterson and David Williams. "If there was a single hero of the show for us," stated Dutton, "it would be David Williams. It was his bulldog tenacity in juggling dozens of elements over innumerable tests that ultimately made the shot successful."

At the castle, Kara, Draco and Gilbert decide to return to Kara's village to organize a peasant revolt against Einon. The cynical Bowen refuses to join the fray, however. Alone and miserable in the knight graveyard, Bowen is haunted by the voices of Arthur and the knights as a column seems to transform into the face of the old king. A column built by the art department was carved on one side to resemble the head of King Arthur and rigged to rotate. "They shot both sides of the column," Squires explained, "relying on us to do the transition between the two. The original concept was that we would actually see the head move in a morph, and it would be talking; but after we shot it, Rob realized that it would probably be better to make the effect more subtle. The face is there, but it is immobile. That way, it seems as if Bowen is imagining the whole thing – which was better than getting too literal with it."

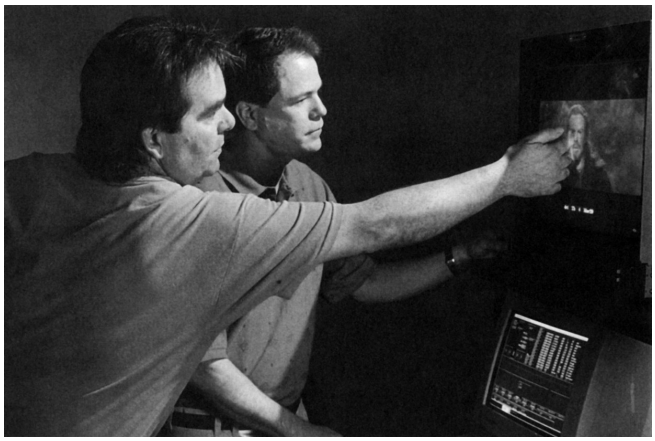
Avalon serves as the site for one of the most eloquent and powerful moments between Draco and Bowen – a scene that takes place when Draco returns to the castle, lands atop a column and delivers a moving monologue. "That shot was animated by Doug Smith," said Straus, "and I think it is my favorite of the show. It is subtle, and yet powerful. Draco has an intensity about him. It is night and he is glistening from the rain. You see all these little changes in his expression as he is speaking; you see it in his eyes and all through his face. That shot represents exactly the type of thing we wanted to do on Dragonheart You can't look at that scene and say, 'That's a really good effect,' because you are completely engaged by this magical, beautiful character. It never ceases to send chills up my spine."

Draco convinces Bowen to lead the rebellion and, in the next shot, the knight arrives at Kara's village, riding to the top of a hill, with the dragon rising behind him in glorious silhouette. "That is a very nice shot," Squires stated. "Even though Draco is in silhouette, his wings are illuminated from behind, creating a translucent look. Whenever he was backlit, we played up the translucency of his wings. Carolyn Rendu painted veins and other things on the wings to suggest translucency – and all of that was built into shaders."

Bowen prepares the peasants to do battle with Einon and his soldiers, and the clash finally occurs in the forests surrounding the monarch's castle. As the men do battle on the field, Draco initiates an airborne assault on the castle itself. When Einon is shot with an arrow, Draco – mortally connected to the king since the sharing of his heart – clutches his chest and falls into the courtyard, where he is set upon and restrained with heavy chains. Although real chain was used on location – mounted to pipes that were manipulated to suggest the pinioned dragon's movements – nearly all of it was replaced by computer generated chain. "We made the CG version bigger because we found that the real chain and cleats looked too small in comparison to the dragon," Squires explained. "The most difficult part was the animation. Every time Draco moved, we had to animate the chains, keeping them taut, yet moving them with the kind of weight real chain has. It took a lot of work to get all of that to look just right – and no one in the audience is ever going to notice it or even think about it."

Intent on rescuing the dragon, Bowen arrives in the courtyard. There, Draco argues that he must be sacrificed if the king is to perish. In an agonizing moment of decision, Bowen takes aim at Einon with an ax, then suddenly turns and throws the weapon into the dragon's chest. The shot of Draco being struck by the ax was one of the last completed by the visual effects team. "The idea was that we would see the ax come in toward Draco," explained Squires, "but we wouldn't actually see it hit him. Rob didn't want the scene to be too gruesome. That was something he was very concerned about, throughout the whole film. He didn't want to get a bad rating for kids; and he also didn't want it to look as if Draco was suffering."

As a result of Bowen's act, both Einon and the beloved dragon die, the latter's spirit ascending to the heavens. The interactive lighting rig used in the first cave sequence was reemployed for the scene, lifted by cable across the courtyard and up over the castle walls. ILM then had to replace the rig with a computer generated spirit. "At the start of the show," recalled Squires, "we had collected videotape of all different types of spirits and glows from various movies. But Rob didn't want anything like that. He didn't want a hard-edged, 'effectsy' look to it. He wanted something entirely new. We experimented with Dynamation until we got a spirit look that was completely original."



Visual effects supervisor Scott Squires and digital effects supervisor Kevin Rafferty review footage of Bowen in the dragon's cave. Squires and his ILM crew devoted two full years to the Dragonheart assignment.

“Tony Plett did a fantastic job on this sequence,” said Kevin Rafferty. “We checked into the new particle renderer that was developed for Twister by our software department, and saw that it could add a certain finesse to the Dynamation package. Tony went for it, and the outcome was startling.” Draco’s spirit continues to rise until it becomes a bright star in the heavens, encircled in a brotherly embrace by the other stars forming the Draco constellation.

Because Rob Cohen would be shooting his next movie in Rome throughout much of the year-long postproduction, a satellite assisted fiber optic link was established between the director and ILM. The link enabled Cohen to review shots in progress and maintain daily contact with the effects team.

At the end of March 1996 – two months before the movie’s release – ILM concluded its work on Dragonheart Although relieved that the year-long job was finally over, the animators, in particular, handed over their final shots with some reluctance. “You never finish animation,” Straus reflected, “you just stop it. Even if we got the chance to start all over on the shots now, we could continue to improve them and do a better job, on and on and on, until the end of time. As much as you want to complete your shot, deep down there’s always the feeling that if only you’d had one more day, you could really have nailed it.”

Nailed or not, Dragonheart had come to an end. Looking back on the project – a project that had consumed a full two years of his life – Scott Squires could only speculate as to what the significance of the film would be, in terms of visual effects. “I think what we’ve done is to create a real character,” Squires observed. “Draco is one of the first CG characters to reveal a full range of emotions. Getting that character to come to life and interact within a totally real environment was so difficult it could not have been achieved until now. In that way, Dragonheart has opened up many filmmaking possibilities.”

“It was a huge leap forward from just doing dinosaurs,” James Straus elaborated. “When we got to the end of Jurassic Park, I was looking at those shots and saying, ‘Ho-hum, yeah, I guess that’s good.’ The spectacular quality of the dinosaurs was lost on me by the time we got to the end. But on this show, I’m still astounded by Draco. I can still look at shots and think: ‘Wow! How did we do that?’ It’s phenomenal. What we’ve done on Dragonheart is right at the edge. It doesn’t get much harder than this.”

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RIDERS ON THE STORM

image

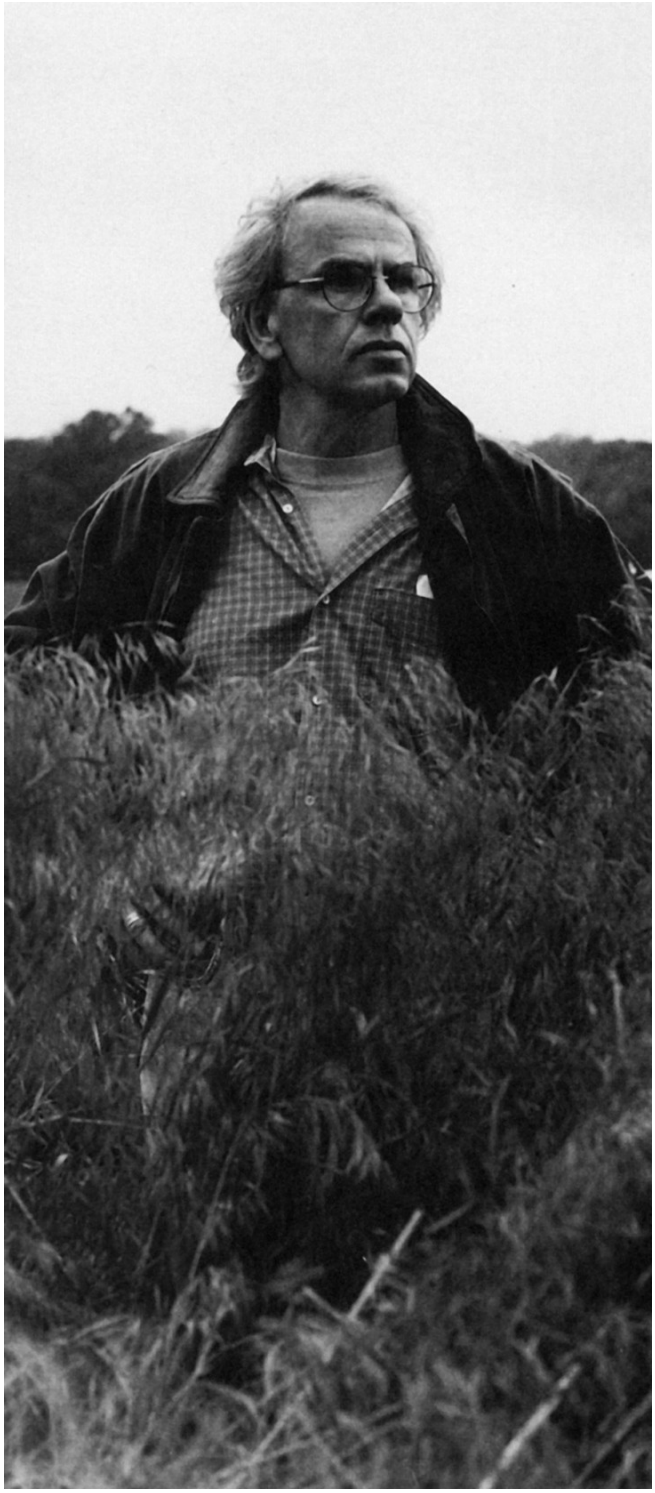
article by
Jonathan Luskin

In Twister, Bill and Jo Harding – an estranged husband-and-wife storm-chasing team played by Bill Paxton and Helen Hunt – reunite in an effort to implant a high-tech tracking device within one of a cluster of tornadoes descending on Oklahoma's 'Tornado Alley.' The Amblin Entertainment production – written by Michael Crichton and Anne-Marie Martin – employed a multitude of physical and digital effects to depict the awesome power of the often-deadly storms.

In 1994, Dutch-born cinematographer Jan De Bont – director of photography for movies such as *Lethal Weapon*, *Basic Instinct*, *The Hunt for Red October* and *Die Hard* – made his American directorial debut with Speed, a nonstop action picture that lashed audience members to their seats for 115 minutes of unblinking suspense. This year, De Bont has returned with Twister, an Amblin Entertainment production. Written by Michael Crichton and Anne-Marie Martin, Twister was produced by Kathleen Kennedy and Ian Bryce, with Steven Spielberg acting as executive producer.

Bearing the Crichton stamp of science-based intrigue blended with down-and-dirty action, Twister revolves around two rival groups of scientists, each racing to be the first to place its sophisticated tracking device – coyly named 'Dorothy' – within a tornado. Telemetry data transmitted by the device will be invaluable to the study of tornadoes, and may eventually lead to life-saving advances in prediction and tracking.

Leading one team, a low-budget band of dedicated academics, is Jo Harding (Helen Hunt), a woman obsessed with tornadoes since childhood. Preparing to follow a huge cluster of storms approaching Oklahoma's 'Tornado Alley,' Jo and her team are joined by her estranged husband, Bill (Bill Paxton), a one-time storm chaser who has since opted for a less stormy life as a television weatherman, with a less stormy woman, fiancée Melissa Reeves (Jami Gertz). Initially interested only in having final divorce papers signed, Bill is soon caught up in the thrill of the chase.



Cementing the reputation he established first as a cinematographer, then at the helm of Speed, director Jan De Bont molded Twister into a roller coaster of action, suspense and spectacular effects.

Racing against Jo, Bill and their crew is a lavishly funded, corporate-sponsored team headed by Jonas Miller (Cary Elwes). Throughout a harrowing day and night, the two groups are pitted against each other and against a series of ever more life-threatening tornadoes – ranging from the modest F-1 class twister to the violent F-5, the largest, ugliest concentration of natural fury on the planet.

Introduced to the screenplay in the fall of 1994, Spielberg and Kennedy immediately commissioned a test from Industrial Light & Magic to determine the feasibility of creating realistic tornadoes through digital techniques. “Amblin was very concerned about the variety of tornado looks that we could produce,” recalled ILM visual effects producer Kim Bromley. “They felt that if we couldn’t do it digitally, then there was no point in pursuing it at all.” Bromley, who had taken a leave of absence after her work on Disclosure, was attracted to the project and promptly rejoined the ILM team, working with Dennis Muren – charged with supervising the test – CG supervisor Habib Zargarpour, modeler Stewart Lew, painters Carol Hayden and Scott Frankel and animator Dan Taylor.

The test, which took approximately ten weeks to complete, consisted of a point-of-view shot through the windshield of a moving pickup truck. Images included a black, angry tornado spinning across a cornfield, a dark rain of debris shooting out of the advancing storm, an exploding barn, and a tractor flying by, nearly grazing the camera. While the test shot would be achieved using a number of computer generated models – such as the debris and exploding barn – the creation of the tornado itself was the most challenging aspect of the assignment. “Attempting to create photorealistic clouds of dirt in the computer was really exciting,” Zargarpour said. “No one yet had a good grasp of it. In past attempts, you could always see that it was a computer simulation.” To create the tornado in the test shot, Zargarpour employed Wavefront’s Dynamation, a particle system software he had utilized on *The Mask* and for *Star Trek* Generation’s nebulous energy ribbon. The resulting shot was so engaging, it was cut into the movie’s teaser trailer.

On the strength of the ILM test, Twister was greenlighted in winter 1995 and the filmmakers were catapulted into a hectic preproduction schedule – primarily because plate photography would have to begin in time for the early spring tornado season. In the following weeks, a production office was set up in Oklahoma, where much of the picture would be filmed. John Frazier was brought on as special effects coordinator – a position he had held on Speed, Outbreak and In the Line of Fire. It would be up to him to create, through practical means, the illusion of approaching storms. At ILM, meanwhile, the visual effects supervisory baton was passed from Dennis Muren to Stefen Fangmeier, who had just served as co-effects supervisor for Casper. Twister would be his first solo outing as supervisor. “Twister was interesting to me because it required animation that was on a more chaotic, natural level,” Fangmeier said. “It was a chance to broaden ILM’s visual effects palette.”

By April, De Bont was ready to begin photography. First unit filming in Oklahoma and Iowa took place over the following four and a half months, while two second unit camera crews were dispatched to Oklahoma specifically to capture footage of storm fronts, cloud formations, and even live funnel clouds. Unfortunately – at least for the filmmakers – the region was experiencing one of its most uneventful tornado seasons in years; and although the second units were successful in shooting dramatic footage of a stormy mesocyclone – a precursor to a tornado touchdown – an actual tornado was never captured on film. The result was that all of the tornadoes featured in Twister were realized digitally.

The original plan had been to composite those digital tornadoes into background plates of real approaching storms. But, not only were the camera crews unsuccessful in capturing tornadoes, they were ‘blessed’ with nearly constant sunshine – a weather condition that would be welcomed on

most movie sets, but was a detriment to Twister. In fact, by the end of the summer-long shoot, the film company had encountered only three weeks of the necessary cloudy weather. Thus, most of the background plates featured little or no show of force from Mother Nature. To create the impression of a tumultuous tornado season, the filmmakers had no choice but to rely on effects. "There were a lot of meetings between Jan, Stefen, John Frazier and myself," recalled Ian Bryce, "concerning how we were going to create the impression of bad weather when it was blazing sunshine on location. We had to figure out what could be done practically, what could only be done by ILM, and how we were going to blend those two elements together."

Among the tasks originally assigned to the practical effects team was the simulation of the tornado's approach – achieved by blowing vast quantities of debris across the set. On location, John Frazier was joined by his crew of fifty practical effects experts, including mechanical engineer Ralph Kerr, electrical engineer Arnie Peterson, general foremen David Amborn, Bruce Hayes and Chuck Gaspar, first unit set coordinator Jim Schwalm and second unit set coordinator Steve Bunyea. "Ralph Kerr designed a jet-powered debris blower for the show," explained Frazier. "We got two Boeing 707 jet motors and mounted them on two forty-foot trailers in such a way that they could pan and tilt. Each one of the motors put out ten thousand pounds of thrust." Mounted above the jet motors were eight-foot-square, twenty-foot-long hoppers. "We filled the hoppers with lightweight debris – stuff that didn't have any sharp edges – and we'd pitch it in the path of these jet engines."

Early in the film, Bill and Jo drive their pickup truck into an irrigation ditch as they attempt to intercept – and then escape – an advancing tornado. All of the twisters – ranging from the relatively mild F-1 class to the hugely destructive F-5 – were created digitally by Industrial Light & Magic. The digital team customized particle system software to realize the tornadoes, which were carefully animated to suggest turbulence and gravitational forces.

Since numerous tornadoes were to be depicted in the course of the picture, ILM sought to give each a unique look and identity. A shot through the pickup windshield reveals a waterspout rising from a lake. The waterspout was computer generated, then composited into location background plates.

The storm debris consisted solely of biodegradable materials so that, if some of it was missed in cleanup, it would not harm the local environment. "We went to a factory that does blow molds," Frazier recalled, "and they made up tons and tons of things – biodegradable milk bottles, dishes, anything that logically could get caught in the path of a tornado. For weeks, all we did was make rubber tree branches. We had four trailers full of them. After the shoot, we would hire the Boy Scouts to clean up the location. Even though the stuff was biodegradable, it still looked like trash."

Blowing dust was achieved by positioning a venturi tube in front of the jet engines. "We could stick different colors of dust in there," Frazier related, "whatever the director wanted. Normally, when you throw dust in front of a fan, most of it goes on the ground; with these jet engines, a bag of fuller's

earth could cover an acre of land. Once this stuff got into the airstream, it atomized; and every particle was suspended in the air."

Shortly into production, the practical approach to creating dust and debris proved problematic. Not only was the dust irritating or even dangerous to the actors, the dust and debris would be nearly impossible to articulate out of the background plates when it came time to composite in the CG tornadoes. To avoid these problems, the decision was made to add much of the dust and debris in postproduction. "At one time," stated Bromley, "it was assumed that we would shoot practical rain and debris elements, and composite that stuff in. But each shot was specific, and the camera was moving all of the time; so it became very clear that we couldn't just shoot these elements separately on the stage and put them into every shot. We would have had to custom design a camera move for each shot. It was better to come up with a way to do it digitally and run with it."

Eventually, the digital team was also called upon to correct signs of seasonal changes that became apparent as the almost five-month-long shoot progressed. In fact, it was just such a change that made it necessary for the production to uproot and move from Oklahoma to Iowa two-thirds into the principal photography schedule. "The wheat fields in Oklahoma were ripening," explained Fangmeier, "actually turning from green to yellow. So we moved to Iowa, which had mostly corn fields. But once we got there, the corn suddenly started growing tassels. There'd be part of a scene in a cornfield without tassels; then, in the next shot, tassels would be popping out. We knew that those things would have to be fixed in post."

Although the 'fix-it-in-post' approach helped keep the main unit on schedule, it also served to double the ILM shot count. "We ended up with more than three hundred shots," related Bromley, "135 of which had tornadoes." To accommodate the considerable increase, ILM rapidly assembled a large crew of about thirty technical directors, thirteen compositers, nine rotoscope artists, nine match-movers and five modelers, along with texture artists, computer graphics supervisors and coordinators. "Hiring and training technical directors became a priority," stated Fangmeier. "This show was so different and the technology was so new, there was a lot of training involved, even for company insiders."

Among the first problems addressed by the burgeoning ILM crew was that of creating computer animated debris. "We went out to the parking lot and threw boards and leaves at each other," recalled computer graphics supervisor Henry LaBounta, "just to see how heavy things move as compared to light things. But the problem wasn't just putting debris in – the first and second units had shot debris on location and we had to match what they had done." To simulate debris, LaBounta and technical director Mike Ludlam modified particle system software so that control of individual particles could be retained. "There are times when the effects supervisor or director wants to change the behavior or movement of a specific particle. But most particle systems, like Dynamation, don't accommodate that. So the problem was finding one of a thousand particles and making that one particle do something different than what the others were doing. We solved the problem when Hiromi Ono wrote software to change the animation curves on any one of the particles, or delete them, or whatever we wanted to do."

While flying debris was important in signaling the arrival of tornadoes, the centerpiece effects were the tornadoes themselves. The storm chasers' first one-on-one with a twister occurs fairly early in

the film. Following the tornado in a pickup truck, Jo and Bill wind up ducking for cover in an irrigation ditch as the tornado roars overhead. The irrigation ditch sequence served as a test bed for the development of production methods used throughout the film.

Behind the design of the tornadoes was an appreciation of their cinematic heritage. “For scary, mind-boggling tornadoes,” claimed Bromley, “the standard is *The Wizard of Oz* – that’s the bar you must jump over.” To prepare for that challenge, Fangmeier and his crew studied many hours’ worth of tornado reference footage. “The fact that most of the reference was shot on home video gear,” said Fangmeier, “and was therefore of very low image quality, only left us guessing what things would really look like when we captured a twister closeup on 35mm film.” In the end, the reference material served as a guide in the creation of the tornadoes, but not as an exact blueprint. “We realized that we couldn’t be hampered too much by scientific reality. We needed to exaggerate things and put a lot of drama into the tornadoes. We leaned on science for a foundation; but we often had to go a bit extreme to get the impact that the director wanted. De Bont wanted something that would shock people and blow them away. We were creating an aesthetic art piece, not a scientific visualization.”

Special effects coordinator John Frazier mounted a huge physical effects effort to simulate the tornadoes’ fury on set. A shot of the pickup in the irrigation ditch is rigged for storm effects by the crew.

In a subsequent tornado chase scene, the pickup is pummeled by driving rain and hailstones. For closeups, Frazier rigged ice machines to spew golf-ball-sized hail toward the truck. Wider shots incorporated computer animated hail.

A truck-mounted rain machine provided the production with portable rainstorms.

The effects team was also responsible for wind and blowing debris signaling the twisters' approach. Jet engines were mounted on trailers to blow lightweight biodegradable matter into the air. The inclusion of debris was ultimately turned over to the digital team when difficulties arose in articulating practical debris out of background plates.

Art director Guy Dyas also studied the tornado reference, then created storyboards using video prints of the background plates. Sampling existing tornado photographs, Dyas composited them together with the backgrounds using PhotoShop. “I made numerous composites to suggest many different kinds of tornadoes,” Dyas recollected. “There were a lot of tornadoes throughout the film, and we didn’t want to confuse the audience by showing similar looking ones. So we designed some that pick up big ugly dust clouds, and others that are beautiful and white.”

In the irrigation ditch sequence, Jo and Bill leap from the pickup moments before it is sucked into the vortex of the tornado. The effects crew suspended the truck from a crane to execute the lift and subsequent drop.

Two basic methods were developed for modeling the tornadoes in the computer: one for the F-3 and smaller tornadoes, and a second for the larger F-5 tornadoes. The former were modeled on a conical patch in Softimage, then deformed in proportion to an animated spline. Several layers of patches with noise shaders were composited together to soften the effect. “Essentially,” stated Zargarpour, “the tornado was spinning so fast that we could model it as a solid plume with no real motion. Ben Snow and Mitch Deoudes worked on that method in the beginning of the project.”

For the more ambitious F-5 tornadoes, the digital team employed a massive number of particles rendered with ILM’s in-house renderer. Creating sufficient particle density was always a problem. “Fortunately, we were allowed to cheat,” observed Zargarpour. “The key was to get enough density to be able to see the definition of the surface. We didn’t need to fill the entire volume, and we didn’t need to worry about seeing all the way through the tornado. Essentially, we just made ‘icing’ on a thick shell. We used what I call the ‘lethal chaos theory’ – we threw a bunch of particles into a chaotic environment; and if some didn’t do what we wanted, we eliminated them.”

All of the tornadoes were created using Dynamation particle system software. A key attribute of the system was its extensibility through modules called ‘clip effects.’ “The intention of the clip effect – written by Henry LaBounta and Chris White – was to reduce some of the trial and error,” noted technical director Ben Snow. “We knew we were doing twisters; so we made the system specifically to do that, writing all our own rules to create the vortex and the turbulence.”

Research and development of an approach for animating the tornado particles was led by Henry LaBounta, whose goal it was to preserve the dynamics of the particles while still being able to control them. “By its very nature,” LaBounta said, “dynamic simulation is erratic and hard to control. Once you start it up, it’s going to do what it’s going to do. On the other hand, I have found that if you overly constrain particles, they lose all their magic. You want them to be a little bit unpredictable, but you also want to be able to do what the effects supervisor wants.” To gain that control, LaBounta

charged technical director Chris White with writing a clip effect interface that would allow for custom-animated forces such as turbulence and gravity.

The computer animation team soon learned that, in regards to tornado animation, slower meant bigger. “A lot of people would assume that you’d have to spin a tornado really fast,” Zargarpour commented, “but when we looked at the reference footage, we saw that the dust was hardly moving. Even on a small tornado, the dust spins relatively slowly, taking a good five or ten seconds to complete a revolution. Only the inner core is spinning extremely fast. Especially on a large tornado, slower is more scary – the slower it moves, the more massive it looks. If it moves too fast, it looks like a miniature.”

To realize the final tornado shots, Florian Kainz developed sophisticated rendering software that had the capability to light and render soft-shaded particles. “With the custom particle renderer,” explained Zargarpour, “we were able to simulate what happens when dust particles in the air are lit from the front, side or back. When clouds are of medium density, you can see dark areas where light can’t get through and really bright areas where the cloud is thin. The components that contribute to the look of the dust include the density and how much light can get through. The problem with lighting a particle tornado is that if the dust is too thin, light will shine all the way through, making everything bright, with no definitions. But if it is too dense, no light will get through, making the tornado a solid blob.”

One of the problematic areas was where the top of the tornado had to blend convincingly with the clouds in the sky. De Bont requested that the clouds at the top of the twister be made to rotate as well, sparking the development of new techniques. “We thought we were going to have to paste moving footage from the reference material into the sky to create the clouds,” recalled LaBounta, “but Ben Snow and Ken Wesley did an incredible job simulating that artificially. Some of the shots used shaders mapped onto rotating spheres. Others used 2-D morphing tricks. Ken and Tom Martinek also experimented with lattice deformation on a patch. Whichever technique we used, the lighting had to work to avoid seeing any hard edges or intersections. In the end, we were really surprised how convincing we could make that look.” Some of the tornado shots used clouds made entirely of particles.

Even after making their way to the compositing stage, the tornado shots still required a great deal of work – especially since they were being composited into background plates that were often cloudless and far too bright. The first step in assembling the shots was pulling a matte for the sky so it could be darkened, clouds could be added, and a tornado inserted into the scene. Mattes were often required in the foreground or for trees on the horizon. “With the extremely bright blue sky we were able to use standard digital bluescreen extraction techniques,” noted CG supervisor Sandy Karpman, “but there were reflections on the trees, which made holes. Rotoscoping was required to finish the mattes.” To counter the unusually sunny weather on location, many background plates needed to have their sky luminance reduced or, in some cases, clouds added for a total sky replacement. “Some shots just needed the blue channel brought down. Our goal was to keep the luminance and saturation constant throughout a scene. If we knew we were going to composite a tornado into the scene, we spent the extra time to put in really beautiful 2-D or 3-D clouds.”

To properly composite clouds and other elements into the background plates, the virtual camera had to be match-moved to the live camera. This was a manual process on the computer, since motion control cameras were not used on location. The plate camera was often mounted to a moving vehicle, or even hand-held by the cameraman as the truck bounced down rough Midwestern roads. “I quickly realized that I would have to let Jan De Bont shoot the picture without restricting him too much,” said Fangmeier. “It would have been a disservice to the documentary style he was going for, and would probably have slowed down our progress on location more than the difficult circumstances already did.” As a result of the freewheeling camera style, reference points for tracking the camera moves were few and far between. “Usually we get information about the live-action camera move by putting reference objects like cubes or tennis balls into the scene. But on Twister, De Bont would hand-hold the camera in the car, and we would drive down a mile of road and have three or four takes panning from the road to the actor. Even if we had a hundred background references, we would have had no sense of where to put them. In addition, De Bont would sometimes shoot as many as eight or nine cameras at once. We had no idea which camera take he was going to use. It was almost impossible to accurately measure and get all of that information.”

Matching the camera moves was accomplished ultimately through a combination of 2-D and 3-D methods, developed by lead match-mover Terry Chostner and supervised by Karpman. “If we were lucky, we’d have a few measurements of some object in the scene – such as the size of a tree – as well as the camera lens,” said Karpman. “Then we would build the object and a ground plane in the computer and track it in 3-D. Camera shake was often added to the shot digitally using ILM proprietary 2-D software.”

Compositing of the elements was an effort organized by 2-D supervisor Tom Rosseter. “The biggest challenge we faced,” Rosseter noted, “was where foreground objects met the new background and there was a lot of activity – light-colored hair blowing in front of a light-colored background, for example. We had to not only extract mattes from those things and combine them with painstakingly drawn roto-mattes, we also had to make them look as if they were all lit by the same source. Fortunately, we could correct the contrast and light levels and manipulate the shadows to some extent. Sometimes, however, it reached a point where we said: ‘We can probably figure out a way to do this procedurally with the computer, but why jump through hoops? Let’s just paint it.’“

Through the process of executing the irrigation ditch shots, the ILM team had solved many of the show’s inherent problems. The sequence continues with the tornado chasing Jo and Bill in their truck, then suddenly veering off and pulling apart a nearby barn. “We found that if we gave the tornado a direct course, it didn’t look natural,” observed Guy Dyas. “It had to be all over the place. In the reference footage we looked at, the tornadoes changed direction a lot. There was no telling where they would go from moment to moment.”

Dyas designed the exploding barn, which was then modeled by Stewart Lew. Techniques for suggesting its destruction were developed by Zargarpour and Ben Snow. “We had to explode three thousand parts of the barn,” Zargarpour recalled. “To do that, we took each control vertice from the barn model and converted it into a Dynamation point, then ran it through a simulation. The barn pieces all stayed in place until the center of the tornado was within a certain proximity. When the tornado was close enough, a chunk of the barn was pulled up into the vortex and turbulence. The tornado and barn simulations were run at separate times, then mixed together by the Tenderer, which also mixed in the dust elements. Having a very detailed model, a good paint job and good lighting all helped to tie it together.”

Straight out of Oz, a twister carries a barn explodes itself in by a bomb. The tornado, barn and particle system debris, were all computer-generated.

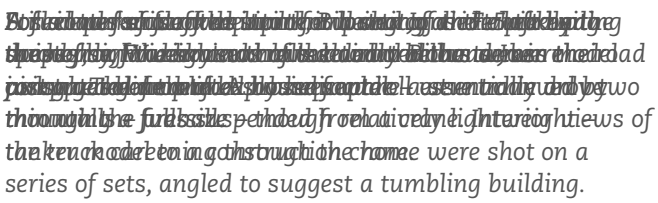
pulled away from the core as the digital tornado reached a certain proximity. To accommodate Jan De Bont’s high-energy directing style, nearly all of the effects plates were photographed using hand-held cameras in fast-moving vehicles. As a result, CG elements had to be painstakingly match-moved into bumpy, documentary-style backgrounds.

Having survived the irrigation ditch, Jo, Bill and Melissa drive onto a causeway crossing a large lake, only to find themselves trapped in the middle, surrounded by water and threatened by waterspouts. Technical directors Sean Schur, Amelia Chenoweth, Natasha Devaud and Roger Guyett worked on the effect. “We wanted to design something elegant, but with an element of danger,” said Guyett. “The waterspouts were an opportunity to create something visually different than the other tornadoes. Some of the reference waterspouts had a very transparent, almost glass-like column rising out of the water. At the other extreme, there were very turbulent spouts that churned up massive amounts of water and generated huge clouds of spray. We used elements of both types.”

Due to the number of elements involved, modeling of the waterspout was considerably more complicated than the modeling of the land tornadoes. “We used RenderMan shaders to simulate very turbulent moving surfaces,” said Guyett. “Then, as the tornadoes got closer and closer to camera, we began to incorporate more and more Dynamation particles. They were made up of multiple layers. We had the turbulent water on the surface, forming the initial twenty-five or fifty feet of the tornado. That would then settle down into a more stable column of water rising up into the sky.” The waterspout animation differed from that of the land tornadoes, as well. “Waterspouts are generally smaller, so we animated them to move more quickly. We wanted to create the idea that these waterspouts are extremely erratic and unstable, so we had one of them eventually split into two.”

As the team sits trapped inside the pickup, the advancing funnel lifts a cow into the air. The cow was modeled by Wayne Kennedy, painted by Carol Hayden and animated by Peter Daulton. “From an animation standpoint,” said Daulton, “an animal that is flying through the air – as opposed to walking or running and having contact with the ground – gives us a tremendous amount of freedom. I think we pushed the envelope on believability a little bit, but it was hard not to make it humorous. The cow looked as if it was not happy being up there. When

we showed it to De Bont, he laughed for about a minute."



The interior of the truck and the exterior views through the windshield were shot on a series of sets, angled to suggest a tumbling building.

Compositing the flying cow was unusually difficult since, in several shots, the animal was viewed from within the truck, through a windshield spattered with rain. "We had two versions of the plate, one wet and one dry," explained Guyett, "so we had a choice of going with a dry windshield and recreating the rain, or trying to put the cow behind the rain that was already on the windshield. In the end we decided to go with the wet plate, because trying to recreate the water would have been too difficult. Then we had to find a way to isolate the rain on the windshield without having to do a lot of rotoscoping. The main advantage we had was that the windshield wipers were moving fairly quickly, so from one frame to the next it was difficult to detect any lack of continuity."

A fresh tornado report soon comes in, and Jo leads her team to meet it. Hail begins to fall as they chase the storm up a long hill. Practical hailstones were required for closeups, and John Frazier had searched for months to find a method to create the desired effect. "Normally, ice machines are used for making snow," Frazier said, "but we changed a few gears inside one and were able to get big hailstones out of it – about golf ball size. The production was concerned that somebody would get hurt, so I tested it on myself. The machine pitched hailstones up in the air about fifty feet; and every once in a while one would hit me – I could feel it, but it wasn't bad." De Bont and the producers subjected themselves to the same test before approving the device. "When we got to Iowa, we took a trailer and put three ice machines on it. In the morning, and again at lunch, we would load these huge hoppers with ice, adding a gallon of milk into each 350-pound ice block. What these machines produced looked just like hail." While the practical hail sufficed in closeup, master shots featured computer animated hail, developed by Greg Killmaster and Amelia Chenoweth at ILM. Particle system techniques were employed in combination with 'hero' hailstones, animated in Softimage and rendered with RenderMan shaders to give them visible shape and shading.

After the hailstorm – and with the truck needing repair – Jo's team holes up in a garage across from a drive-in theater. A nighttime tornado destroys the theater, tossing its marquee and a number of automobiles into the air. The ILM team enjoyed a good deal of creative freedom in designing the night tornado. "There's a great shot in the drive-in sequence where you're aware of the tornado, but the sky is completely black," noted Dyas. "The tornado is only visible in flashes of lightning. De Bont wanted lightning to travel down the middle of the tornado and light it up from inside. We followed through with that idea and added to it by making the lightning travel in a corkscrew pattern around the inside of the tornado." Leah Anton painted both the lightning and the flashing clouds by hand.

Near the film's climax, the team heads off to chase one last, huge F-5 tornado. When they finally spot the ominous black cloud, it appears to be carrying a shiny piece of debris that, upon closer inspection, proves to be a fuel tanker truck. Their pickup caught within the branches of a fallen tree, Jo and Bill can only watch as the tanker suddenly falls onto the highway and begins to roll towards them. Bill

The F-5 – cutting a mile-wide swath across the Oklahoma prairie – bears down on an isolated farm.

manages to accelerate just as the truck explodes in front of them. The out-of-control pickup moves through the wall of flames and out the other side. Shots for the sequence were captured, in part, with a full-size tanker model built and detonated on the set. "We duplicated a real fuel tanker, using mostly aluminum and fiberglass," stated John Frazier. "The tires were lightweight rubber. The model ended up weighing about three thousand pounds."

Uncharacteristically sunny weather during principal photography often resulted in backgrounds that were insufficiently dark and cloudy to suggest tornado weather. ILM corrected the problem in postprocession. Some shots needed only color correction, while others required the replacement of entire skies with computer generated cloudscapes.

Having succeeded in planting the tracking device in the path of the storm, Bill and Jo run for cover as the tornado gains on them, uprooting fence posts and rendering them lethal projectiles.

The trickiest, and most dangerous, part of the sequence was the tanker's drop onto the highway and the subsequent explosion – all with the pickup driving through. To realize the shots, the tanker model was pyro-rigged with four hundred gallons of gasoline and dropped from a construction crane. "It was critical that everything be in sync," noted Frazier. "We calculated that it would take two seconds for the tanker to hit the ground after dropping from the crane. The pickup was traveling at fifty feet per second, which for two seconds is one hundred feet. So from where the tanker was to hit the ground we walked off one hundred feet down the road. I got with the stunt coordinator and De Bont, and said, 'Right here is where he is going to run into the tanker.' Then we walked off what we thought would be a safe margin – about another seventy feet. I said, 'When the pickup passes that point, I push the button and the tanker falls.' That was the dead zone. I had a radar gun; and if the driver of the pickup wasn't dead on, within one mile per hour, then we were going to abort. The stunt driver drove back about two miles, got the truck up to forty miles per hour, then put the car in cruise control, not touching the gas pedal. When he reached the mark, I hit the button – and everything just blew right past him. He had a Lexan windshield and side windows, so he was pretty safe." Ultimately, the tanker in the two dropping shots was replaced by a CG version so that more interesting rotations could be incorporated into the images.

More large-scale practical effects work was required for a shot of the tornado passing by a tractor dealership and lifting its inventory into the sky. Frazier and crew built full-scale, lightweight farm combines and tractors, then dropped them from helicopters. "A real combine weighs in the neighborhood of 30,000 pounds," said Frazier. "Ours came in at about 3500 pounds." ILM subsequently thickened the swarm of debris by adding digital tires, windmill blades, a tractor in the distance and animated combines.

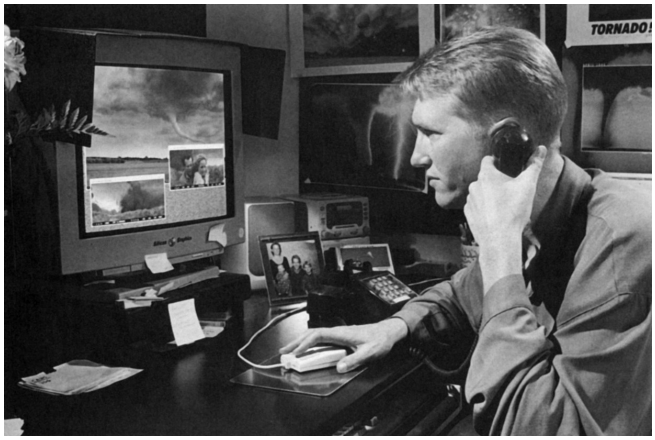
Still in pursuit of the tornado, Bill and Jo careen down the highway. As they round a sharp turn in the road, a house, propelled by the tornado, appears from behind some trees, lands in the middle of the road, and blocks their path. They smash into the house, drive through its interior as it tumbles across the highway, and exit through a wall on the far side.

Production designer Joseph Nemec worked with Frazier and Fangmeier to divide the house gag between the practical and digital effects teams. In addition to building a partial house – two thin walls connected to each other and suspended from a crane – Frazier and his team built an interior for shots of the truck driving through the uprooted building. "The truck drives inside the house," stated Frazier, "up the staircase, through a bedroom, a bathroom, another bedroom, and out the back – and the house looks as if it's turning all the time because of the way we built the set, with each room at a different angle."

Shots of the house rolling through the fields and flying in the air were all done digitally by Stu Maschwitz and Pat Myers. Guy Dyas drew architectural elevation drawings of the complete house as a reference for the computer model. “For the look of the house, we used a lot of textures,” said CG supervisor Tom Hutchinson. “The house had to be rendered in two separate passes – one pass for plastering a paint texture on the side of the house, and then a second pass for all the separate pieces that come off and shatter. We had to paint individual textures on each of the pieces that come flying off.”

With the F-5 fast approaching, Bill and Jo anchor their last Dorothy unit to the truck and drive headlong into the vortex of the tornado, bailing out at the last moment as the truck and Dorothy pack are planted successfully inside the twister. Immediately, valuable telemetry data begins to appear on the team’s computers. These and other graphics displays seen in the film were designed and implemented by Van Ling and Casey Cannon of Banned from the Ranch, a newly founded company that had first caught De Bont’s eye when the director joined Kathleen Kennedy for a tour of the Congo set, where Ling and Cannon had set up a high-tech representation of the fictional company, Travicom.

Similarly, the company’s assignment for Twister was to outfit the National Severe Storm Laboratory set with high-tech paraphernalia, including thirty computer and video monitors and a five-foot diagonal Hughes JVC video projection system. “Traditionally, when you see computer screens in movies,” explained Cannon, “you’re actually seeing 24-frames-per-second video playback disguised as computers. We specialize in using real computers on set for playback, syncing them up to the film camera. As a result, we are able to provide much higher resolution graphics than you would get at normal video resolution. And rather than just accepting what computers can do and working around that – which is typical, since computers on set are considered finicky, child-actor kinds of things – we treat computers like production tools that can be shaped and molded to the artistic eye of the director and the cinematographer, interactively on the set.”



Visual effects supervisor Stefen Fangmeier reviews an effects sequence on his monitor. By the end of the production, ILM had provided three hundred visual effects shots, nearly half of which featured tornadoes.

Although originally built in Los Angeles, the NSSL set was ultimately re-created on location in Oklahoma, due to changes in the production schedule. “It was very different from Congo, where we were working on a set, in a very controlled environment,” stated Ling. “On Twister, Silicon Graphics loaned us $3 million worth of computers – delicate electronic components – and we took them on the road and beat the hell out of them. We actually did a shot where I was running the computers out of my Hummer, and I had a cable going out the window to the picture vehicle. Both were moving. At other times there was pouring rain and blistering heat – 110 degrees and 92 percent humidity. In the hailstorm scene, the Jo team is setting up its computers, so we had an ice machine throwing hail the size of ice cubes at our computers. Running our data cables through the mud, trying to shoot our laptops’ LCD screens in broad daylight – it was ridiculous. But the systems worked.”

Banned from the Ranch contributed an array of simulated weather graphics and other data revealed on computer monitors throughout the film. The company also contracted with Silicon Graphics to provide on-set computer equipment. Banned from the Ranch CG supervisor Van Ling, producer Casey Cannon and technical supervisor Josh Kirschenbaum at work on a graphics display.

Throughout the film, state-of-the-art weather surveillance data is depicted on the NSSL monitors: Doppler radar displaying storm speed and direction; a lightning detection network revealing lightning strikes throughout the United States; the Oklahoma mesoscale network, a statewide network of wind speed indicators; and data from GOES-8, the same weather satellite that provides imagery for the evening news. Banned from the Ranch used a suite of custom and off-the-shelf software to create the screen images, including actual meteorological programs, Earthwatch, an SGI-based newscast weather display program, Wavefront Data Visualizer, Adobe PhotoShop and Electric Image.

Working with actual weather data and the advice of weather experts from the real NSSL, the Banned from the Ranch team attempted to present graphics with as much verisimilitude as possible. “We had to move the real weather data around,” Ling explained. “The storms were supposed to be happening in Oklahoma; but we would find a big storm with a beautiful radar signature in Texas. I had to figure out how to get that data moved over into Oklahoma – which was difficult, since weather data is designed so that you can’t put it in the wrong place. We had to customize the software to do it.” Although realism was a goal, the team was not above manipulating the data for dramatic effect. “Real-time weather data just sits there. It’s like watching grass grow. Our first big concession to dramatic license was to put the weather maps in motion. Our job was to make the graphics exciting and work for the story – at the same time, hopefully, satisfying those dozen meteorologists who were going to watch it.”

Another aesthetic issue was the problem of differentiating between the graphics being viewed by the two separate storm-chasing teams – one using state-of-the-art, high-tech equipment, the other making do with less sophisticated devices. “All the data was the same, but we turned it around,” explained Ling. “Sometimes I made it white on black instead of black on white. That helped to give

it a different look – but at the same time, you clearly got the impression that they were looking at the same data. We designed the graphics for Jo's team with a lot of Internet access, a lot of overlapping windows, which gave it a less integrated look. The feeling is that they are just downloading data. Jonas' team, on the other hand, had very slick interfaces that looked very well funded – as if they had the money to hire somebody to design an interface that made it all transparent for them. We assumed that Jonas' team had computer processing time to spare, so some of their displays were in 3-D mapped perspective."

The Silicon Graphics laptop computers used by both teams – fourteen functional units in all – were designed by Ling and production designer Joe Nemec, custom engineered by Dan Evanicky at SGI, and built by Industrial Design and Engineering, a company specializing in prototypes and real electronics enclosure systems. Like the graphics, the computers were designed to reflect the disparate financial positions of the two storm-chasing teams. "The design for the Jonas team laptops – the high-tech, slick ones – were based on SGI equipment, and included the SGI logo," commented Ling. "But we made the Jo team laptops look like generic, eggshell colored, PC laptops – like a cloned SGI." Silicon Graphics does not actually manufacture a laptop computer; so those mocked up for the film were driven offscreen by an SGI Indy computer at the end of a hidden cable. Since the keyboards on the laptops were not functional, Ling would watch the action on a video tap during filming and make the graphics respond appropriately.

In addition to the graphical data, the film featured numerous video newscasts and storm warnings. To edit those images, the BFTR team set up a mobile video postproduction facility. "We had a full Avid editing setup in one hotel room," described Cannon, "and three SGIs and a Macintosh in another. We ran a cable through the windows from one room to another so we could port data from the Macintosh or the SGI into the Avid or back again. Our editor, Wes Rubinstein, got the actual news anchors from local Oklahoma television stations and shot fake tornado newscasts. We took that, added some of our graphics, added some of their graphics, cut them all together, and put it out on 24-frame playback."

The telemetry data revealed after the Dorothy has taken its ride inside the tornado had to be simple, yet vividly get across the point that the pack was transmitting new and exciting data. "The most graphic way we could show that they had succeeded was to have each dot in a particle system represent one of the sensors in the Dorothy pack," explained Ling. "To do that, we used Wavefront's Dynamation, the same software that ILM used for the tornado effects."

As if in response to being scientifically violated, the tornado turns vengefully on Bill and Jo, who run into a barn for shelter. The barn, however, is hardly a refuge. Rails from an undulating fence slice into the walls like spears. Farm implements rattle perilously on the walls. The couple flees the barn moments before it explodes, taking shelter in a pump house and lashing themselves to an exposed pipe. As the tornado passes directly overhead, they are sucked into it, suspended in midair, retained only by the belt straps holding them to the pump.

The pump house scene was one of the most critical for the practical effects crew. "For four months we were wondering, 'What are we going to do for the pump house scene?'" Frazier recounted. "We realized that if we did it with wires, it would probably look like it had been done with wires. So we all put our heads together and came up with a mechanical room, built on a big wheel so that it

could be rotated. The actors – who performed the stunt themselves – would lose their grip and fall away from the center; and it would actually look as if they were getting sucked up into the tornado. From the camera's point of view, it looked as if they were suspended upside down." Earlier in the scene, the tornado blasts the pump house apart – a practical effect achieved by springing bungee cords attached to individual boards in the pump house. "The bungees were so strong, all we had to do was release them and they would start popping the boards off in the air." The couple survives even the F-5 tornado, and peace eventually returns – both to Oklahoma and to their relationship.

In addition to confirming Jan De Bont's reputation as an action director, Twister marked a new level of cooperation between the disparate disciplines of practical and digital effects. Rather than posing some kind of threat to the craft of on-set effects, John Frazier has discovered, through projects such as Twister, that the availability of digital effects only makes practical effects work more abundant. "Digital effects mean that there are more scripts out there that producers are willing to do," Frazier commented. "The best situation for doing those films is to do live effects for the closeups, then enhance them with digital effects." That sense of partnership extended to the team at ILM, as well. "In many ways," Kim Bromley allowed, "we have the advantage over the practical effects crew. We go into dark little rooms to make all our mistakes, and we don't have to show them to 150 people every day; whereas the practical effects crew is on the line every minute. But digital or practical, it is all filmmaking."

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image

A GIANT PEACH IN THE BIG APPLE

article by
Mark Cotta Vaz

Each morning at precisely 10 a.m., author Roald Dahl would leave the Georgian farmhouse he shared with his family and walk a rose garden path to the work hut where he penned his books. Along the way he would pass a cherry tree whose fruit was always being filched by hungry blackbirds. The situation infuriated him, but also planted the seed of a story idea: what if the ripened cherries, instead of being gobbled up by the birds, grew to gigantic proportions?

Based on the perennial best-selling children's book by Roald Dahl, James and the Giant Peach chronicles the adventures of a lonely young boy who finds escape and happiness with a troupe of human-size insects in a peach that has magically grown to gargantuan proportions. Although live-action sequences were employed at the beginning and end of the picture, most of the story unfolded through the medium of stop-motion animation enhanced with computer generated effects.

That wistful thought evolved into the strange tale of James, an orphaned youngster living in England with his evil aunts in a ramshackle house overlooking the ocean. James escapes by taking refuge in a magically magnified peach – not the cherry Dahl originally imagined – that falls off a tree, rolls down a hillside, splashes into the sea and floats towards the promised land of the Big Apple. Accompanying James on this strange voyage are a sextet of giant insects – a spider, a grasshopper, a glowworm, a ladybug, a centipede and an earthworm.

Henry Selick – a veteran stop-motion filmmaker – directed both the live-action and the animation, overseeing a large crew of artists and technicians engaged in the two-year endeavor.

James and the Giant Peach, published in 1961, was the late author's first children's book and would become a perennial bestseller. But while other Dahl books – such as *Charlie and the Chocolate Factory* and Witches – were eventually adapted to the movies, James remained a pleasure of the printed page. The quirky tale did generate a brief flurry of interest at Disney in the early eighties; but that interest was not revived until a full decade later when the project was placed into the hands of director Henry Selick, the stop-motion specialist who had directed the Touchstone Pictures release *The Nightmare Before Christmas*. In *James and the Giant Peach*, Selick and Disney had found another ideal property for exploiting the charms of stop-motion animation.

Not everyone at Disney was enthused by the idea, initially. "Michael Eisner's first response to the project was, 'What's this about a big fruit and a bunch of bugs?'" Selick recalled. "This was late in 1993; and that particular week, *James and the Giant Peach* was number sixteen on the New York Times children's book list. We pointed out that James had been one of the best-selling children's books for thirty years. We passed all this information on to Disney, and it helped keep the project in development." Between pleasing both the Disney hierarchy and the Dahl estate – with Dahl's daughter Lucy having script approval on the movie adaptation – James' journey from proposal to

production would take almost as many harrowing turns as the perilous journey in the story itself. The first script, by the late Dennis Potter, set the story during *World War II* and went so far afield of the book that it received a thumb's-down from the Dahl estate. In early summer 1994, the project was shut down to address the script concerns even as a budget was being prepared and a crew was drawing up character and armature designs.

In late July, the production was finally greenlighted, and Selick set out to mount the fantastic tale. "It was a tough task to take the book's magical flavor and make it into a Hollywood movie," Selick observed, "one that made sense and had a beginning, a middle and an end. But there was something about James that just hooked me, and I couldn't let it go. One way or another, we were going to make this film work."

Such perseverance had been a hallmark of The Nightmare Before Christmas, the film for which Selick's Skellington Productions and the *San Francisco*-based facility in which it was housed had originally been organized. Dreamed up by its producer, Tim Burton, Nightmare had been without precedent, containing seventy-four minutes of stop-motion, with character designs and live-action-style camera moves that broke all of that discipline's rules. At the time, Skellington personnel acknowledged that perhaps the very future of their medium rested on the success of the film. It had not helped morale on the Skellington stages when word came that Steven Spielberg had decided to use computer graphics, rather than stop-motion, to create the full-figure views of his *Jurassic Park* dinosaurs. "A lot of stop-motion animators thought it was the end of their world," remembered Pete Kozachik, director of photography on Nightmare who would serve as both DP and effects supervisor on *James and the Giant Peach*. "But in retrospect, I think it was just a shifting of priorities, with stop-motion artists appreciated for doing more stylized, and less photorealistic work. We can also thank MTV, among others, for getting nonrealistic, stylized animation into the public's mind."

The stop-motion cause was further buoyed when Nightmare became a modest hit at the boxoffice, earning critical raves and going on to enjoy a successful video release. By the time Disney released Pixar's production of *Toy Story* in 1995, the blockbuster success of that first-ever, all computer animated film did not rock the stop-motion world. With Nightmare under its belt, a confident Skellington crew simply saw itself as a major player in an animation renaissance.

James and the Giant Peach gave further evidence to that renaissance, featuring some fifty minutes of stop-motion animation, bookended with stylized live-action segments shot by cinematographer Hiro Narita on forced-perspective sets erected on Treasure Island – a man-made island housing a recently decommissioned naval base in *San Francisco Bay*. The film also showcased more than 350 classic visual effects shots, ranging from traditional cloud tank and cel animation work to a full complement of digital effects. Overall, *James and the Giant Peach* would represent a landmark fusion of the physical reality of stop-motion and the virtual reality of the digital realm.

Sony Pictures Imageworks was commissioned to provide seventy computer generated shots, while Buena Vista Visual Effects, Disney's own effects arm, was tasked with 240 digital composites, including more than 180 bluescreens, twenty CG shots and thirty-five complex rod removals. That substantial digital support was feasible despite the production's modest budget. "Computer animation has really come down in cost," noted visual effects producer Nancy St. John, "which is why you see so much more of it in feature films. A few years ago, who would have thought that for

our remarkably low budget we could have this many CG and digital composite shots? But the costs of CG are competitive when you consider what it takes to get more than fifteen animators working on multiple stages." In addition to digital compositing and computer animation, the film would take advantage of other digital tools, such as an Avid digital editing suite for quickly producing rough composites, a 'frame grabber' video image storage system and an off-the-shelf Video Toaster that could store entire sequences for frame-by-frame playback.

Meanwhile, the return of most of the key Nightmare players ensured that the traditional stop-motion work would be built on a solid foundation. Along with Kozachik, veterans included armature supervisor Tom St. Amand, set construction supervisor Bo Henry, scenic coordinator Gregg Olsson, character fabrication supervisor Bonita DeCarlo, and animator Paul Berry, who would assume a supervisory role. In addition, fourteen of the twenty animators on the show had worked on Nightmare. Joining the alumni were new, but highly experienced personnel. "For James," noted Kozachik, "we had a camera crew that was much more skilled than when we started Nightmare. All the hardware from that film was used on this film – and then some. We had fourteen motion control stages on Nightmare, compared to twenty on this film. We also had four motion bases that were used for moving peach models."

The Skellington film crew needed every bit of its combined know-how for *James and the Giant Peach*. Whereas The Nightmare Before Christmas had featured miniature sets ranging from Halloweenland's gothic edifices and cobblestone streets to Christmastown's wintry wonderland, the settings in James would be largely restricted to peach interiors and exteriors, with expansive backgrounds of sea and sky produced as either CG or scanned-in elements. And, unlike the consistent environments of Nightmare, the giant peach would be traveling across a variety of locales that, although fantastic, still necessitated some naturalistic logic.

Production designer Harley Jessup, a former ILM art director, was responsible for designing the film's live and stop-motion worlds. Live-action sets, erected at the Treasure Island hangar, established the tone for the sad existence of James (Paul Terry) and the mean-spirited rule of Aunt Spiker (Joanna Lumley) and Aunt Sponge (Miriam Margoyles). "Henry wanted the live-action sets to be monochromatic, an almost desaturated color," recalled Jessup. "Then, in contrast to the live-action would be the intense colors of the stop-motion adventure sequence."

Given the nature of the stop-motion medium, Jessup's art department had to give special consideration to matters of materials and construction when designing the stop-motion sets; and a close collaboration with construction supervisor Bo Henry was crucial to the process. Although Jessup had worked with Selick on the cutout animated feature Twice Upon a Time, as well as an animated MTV spot, he still had to adjust to the special demands of stop-motion. "Stop-motion had a whole new set of rules, especially in terms of materials, that took me a while to learn. For example, we discovered that fiberfill cloudscapes could not be used because the material would blow and change. Bo Henry and the model guys were aces at making sure they used materials appropriate for stop-motion."

Skellington sets included the icy Arctic – complete with aurora borealis sky – and an underwater graveyard of pirate ships. Half of the movie's one hundred sets, however, consisted of peaches and variations thereof. While most of the peach shots were stop-motion bluescreen elements, the live-action book-end scenes required construction of a twenty-foot-diameter peach – a steel reinforced framework covered with foam and felt, weighing 2000 pounds. The live-action peach was so big, in fact, that it had to be shipped by barge across *San Francisco Bay* to the Treasure Island soundstage and raised into place with a crane arm.

A full peach in proper scale to the puppets would have been six feet in diameter and weighed eight hundred pounds. Since few shots required full views, however, the peaches were created in sections. "There was no practical way we could have hung or mounted a six-foot peach," said Gregg Olsson. "So we produced fifty or so different peach sections that had to match in color and pattern since we were swapping them in and out on our stages. We were constantly battling continuity issues."

The peach sections were built of plaster and fiberglass, covered with an industrial felt for a fuzzy texture, then painted. While awaiting their moments on stage, the sections would be stacked four-high in a corridor at Skellington Studios dubbed the Hall of Peaches. "The horizontal slices had a topmost casting representing one sixth of the peach," Bo Henry explained, "another slice representing one third of the peach from the top, and another representing the bottom third of the peach. We also made a couple of peaches that represented a bottom two-thirds slice." For the few longer shots, requiring a view of the whole peach, the crew also created eighteen-inch peaches used in conjunction with quarter-scale puppets.

To effect movement, the peach sections were mounted on rigs whose functions varied with the type of motion required. "Often," stated Henry, "the peach was mounted on a rotation rig to make it spin

To design James and his insect companions, Selick engaged children's book illustrator Lane Smith, whose conceptual drawings were translated into sculptures and, finally, armatured puppets. One of the principal challenges was to create a stylized puppet for James, who would also be represented as a live boy in the film.

Although all of the puppets had armatured bodies, some had faces that were articulated via replacement

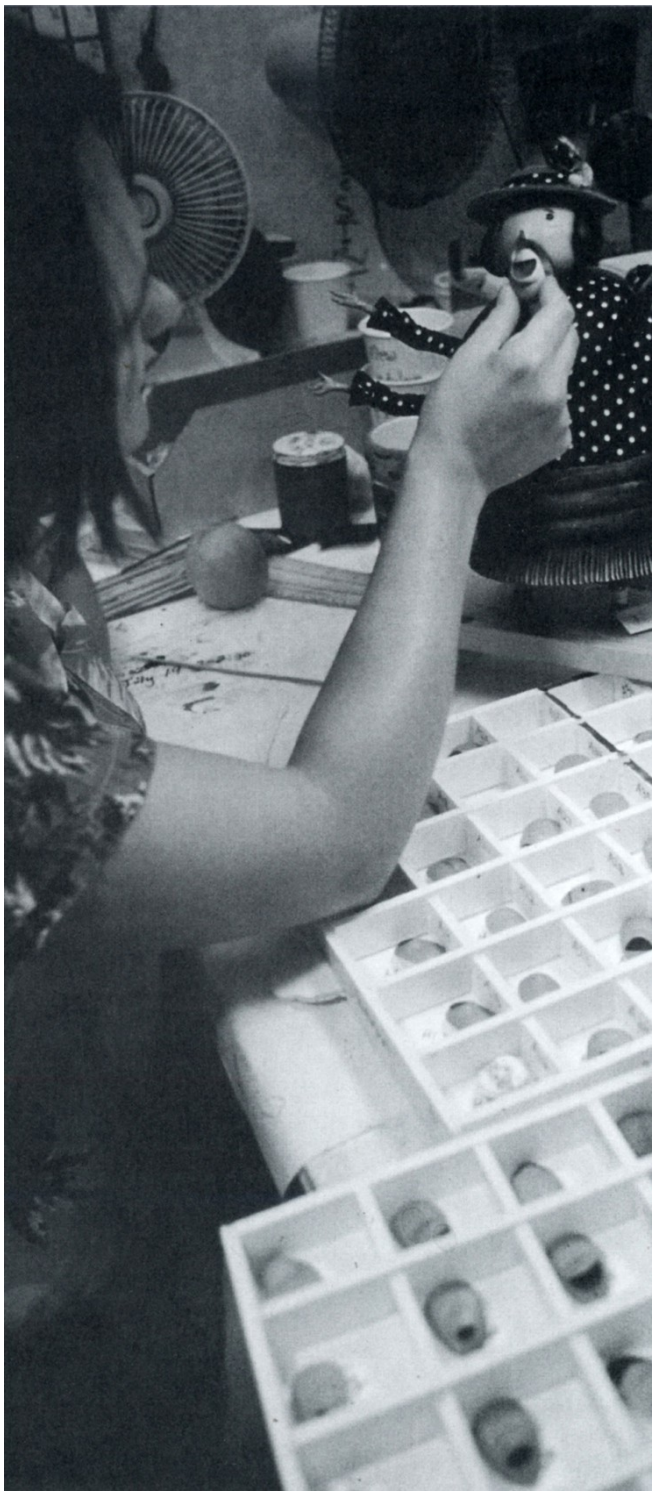
horizontally; other times, when it didn't have to move, it was mounted to a set of stationary legs." In a few cases, movement was simulated simply by moving either the camera or the background.

animation. Forty-seven different mouth shapes were fashioned for the grasshopper. Modelers used clay to create the expressive faces, then cast them in foam latex replacement faces.

Much of the film revolved around life in the peach pit interior. That finite, yet wondrous, space provided a counterpoint to the limitless ocean horizons the group would see when finally clambering to the fruit's surface. "The peach pit interior was one of the biggest challenges we had," Harley Jessup noted, "and Henry encouraged us to try out a lot of different concepts. We started with the idea of a very organic interior, then we tried making it look like the deluxe cabin of a steamship. We wound up with a treehouse-like interior, with areas each of the characters would use as a little home base. Early on, we came up with the idea of garden objects being swept into the peach when it enlarged; so we had the earthworm crawling out of a flower pot, the grasshopper sitting atop a jar. There was also a giant sundial and a garden fork."

Armature engineer Daniel Campbell assembles a puppet armature. Under the supervision of Tom St. Amand, the machinist crew ultimately produced more than one hundred armatures for the show.

A large fabrication department was responsible for creating molds from the sculptures, then casting and painting foam skins. Moldmaker Mark Fiorenza at work on a casting for the earth worm puppet.

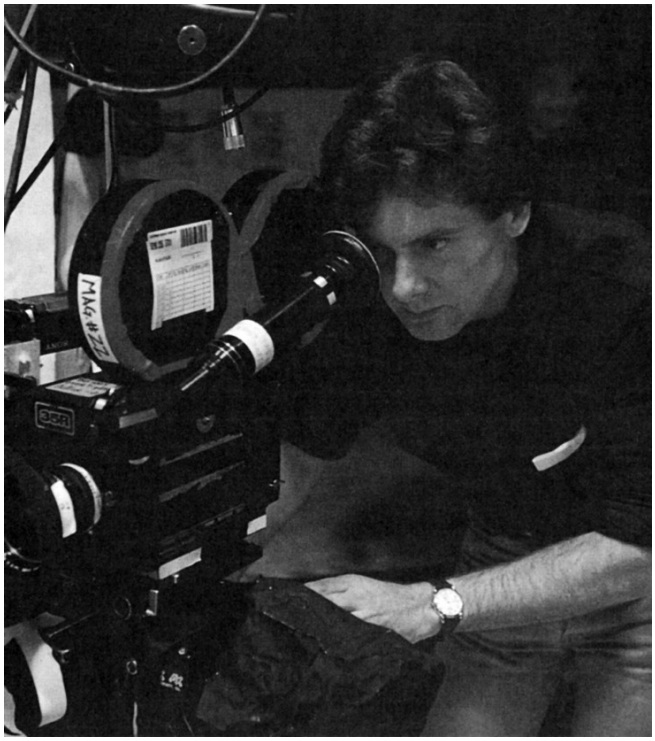


Character fabricator Jessica Ritts Cadrin sorts through the variety of replacement mouths created for the ladybug.

Bo Henry's art department built four peach pit sets, each of which was duplicated to accommodate multiple setups. The pit was made of foam sculpted with a hot wire and epoxied to a wood base structure that provided cathedral-like arches. From the cozy nooks to the vaulting arches, the pit was designed to magically, and subtly, evoke the mood of a particular scene. "When James first falls into the peach pit and meets the insects," Kozachik said, "it's as if he is in a carnival spook house – his first impression of the bugs are black shapes with glowing eyes or mouths. Then the pit becomes a warm, friendly place, with all this rosy light coming through the peach." Varying moods were evoked largely through changes in lighting. "There were a lot of great opportunities in the interior because it was, after all, a fantasy environment and there was no valid light source in there to begin with. A real peach pit wouldn't allow sunlight to enter, but we had cracks where light came through, as well as recessed lighting. Colors varied by mood and sequence with no apologies, with blue at night and yellow during daytime."

Fellow fabricator Donelle Estey fits the centipede's skin onto its armature.

Although the design, construction and lighting of the peach and other sets were major projects, the Skellington crew lent most of its efforts to the development of the stop-motion characters – James and his insect companions. "Since the characters were going to be interacting within the peach's confined space," Selick commented, "we wanted all the puppets to be very expressive, with a lot of repartee going back and forth." To develop the initial character designs, Selick brought in best-selling children's book illustrator Lane Smith. "My own natural design style is a little harsh for most family films. Lane Smith's work looks like a cousin to what I do. It is still wild stuff, but a little sweeter. Lane gets away with abstract forms in these wonderful, glowing oil paintings that are filled with great design and mystery."



Pete Kozachik – who served as both director of photography and visual effects supervisor – lines up a shot.

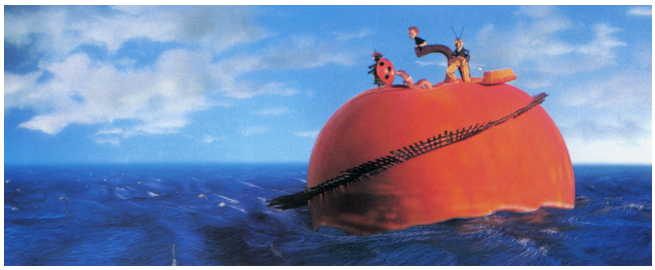
Once designs and schematics were approved, preliminary sculptures were initiated. "A lot of Lane's work is asymmetric," explained Jerome Ranft,

who handled the three-month sculpting period with Damon Bard and Kamela Portuges. “That works great in paintings, but we had to make it more symmetrical for sculpture. The characters that stayed most like Lane’s drawings were the grasshopper, the centipede and the glowworm. In the design phase, there was no other consideration but the design – even though I might have been thinking, ‘If those ankles are an eighth of an inch thick they’ll never be able to get an armature in there.’ Those concerns came up once we started actually producing the puppets.”

The most difficult characters, from a conceptual standpoint, were James and Miss Spider. Unlike the fanciful insects, the James puppet had to replicate the face and form of actor Paul Terry, who was not cast for the live-action segments of the film until late in preproduction. In addition, James was a pivotal character, scheduled to appear in seventy percent of the film’s 550 animation shots. Early puppets simply did not look good enough. “In this movie, we had a live-action boy who becomes a puppet,” commented co-producer Brian Rosen. “The puppet had to maintain the inherent truthfulness of the boy, but with an element of caricature. The question became the appropriate amount of caricature. Refining that puppet put us in a loop for about three months.”

Eight camera crews filmed puppets on a variety of miniature sets. Camera operator Rich Lehmann and camera assistant Kirk Scott prepare for a closeup on a peach section.

While most scenes were captured in-camera on the miniature sets, many required bluescreen puppet photography to be composited with computer generated backgrounds. For a distant shot, animator Josephine Huang manipulates reduced-scale characters atop a full peach on the bluescreen stage.



An extended sequence had the bluescreened fruit composited with computer generated water backgrounds provided by Sony Pictures Imageworks.

Sculptors had taken a too realistic approach to the first version, resulting in a puppet that was a grotesque reflection of reality. “I like to do outlandish designs for characters,” Selick noted, “because then it is more of a miracle when they come to life. But in James’ case, we had to judge him against reality. He represents us in the movie and takes us into that stop-motion world. So we made him more real in our original figure – but it looked like a little animated corpse with all this complex and frightening movement. It just gave you a bad feeling. I think the film would have been really hurt if we had stayed with that overly complex boy.”

Like James, Miss Spider proved a tough character to design, with an estimated one hundred concept drawings flying back and forth between Selick and Lane Smith. Smith, in fact, became so exasperated at one point that he suggested to Selick the character be dropped from the film. “It was almost impossible,” Selick admitted, “because a real spider’s face is so horrifying. But I was very happy with how she ended up, with a half-woman/half-arachnid face. She had a strong shape to her face that was sort of ‘Greta Garbo meets Madonna.’“

Sony was also charged with creating a mechanical shark that attacks the floating peach. To ensure the computer animation would match the movie’s predominant frame-by-frame style, stop-motion veteran Harry Walton was enlisted to supervise the shark sequence.

To escape the beast, the characters take to the air by attaching Miss Spider’s webbing to a flock of seagulls. Although stop-motion birds were used for closeups, most of the flying seagull shots were achieved with computer animation.

Other design issues included the proper means of achieving each character’s mode of expression. Some puppets were animated via replacement parts. *Grasshopper*, for example, had forty-seven different mouth shapes, as well as replacement eyebrows and lids to create a blink cycle, while Ladybug was equipped with a replacement mouth. Endowed with eight expression ranges, Miss Spider required more than 690 replacement faces – a nearly unmanageable inventory for the mold department to provide and coordinate. The character was so troublesome, in fact, that cameras were already rolling before a workable Miss Spider puppet made it to the set. As a result, for a number of weeks the Skellington crew was forced to shoot a nonspeaking puppet lurking in the backgrounds.

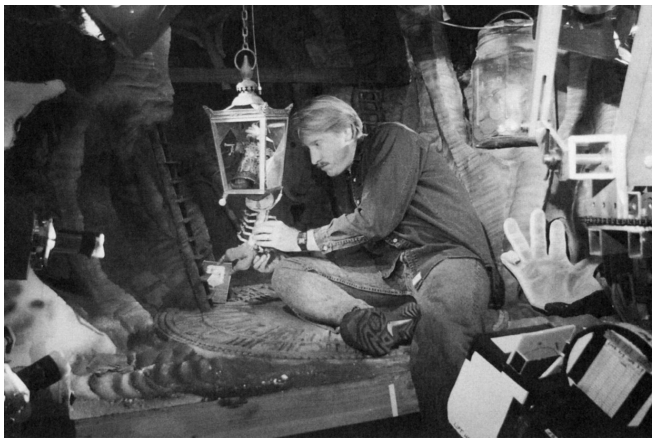
In contrast to the replacement parts approach, James, Centipede and Earthworm had articulated faces and forms that were manipulated to create expressions. Four different styles of articulated James puppet faces were cast in specific emotive categories – neutral, happy, sad and panicked.

Each was made up of a complex system of armature joints, anchored in the puppet skull, that simulated facial muscle groups and allowed for expressive movements. “The final James puppet had a face that was delicately manipulated,” explained animator Anthony Scott. “The cheek had two paddles left and right, the jaw moved up and down, and the bottom lip had two little pins within the armature on a ball and socket that we could move up for a smile, or down for a frown. James was very subtle. His mouth, for instance, wasn’t huge and expressive like the centipede’s; and if we opened it too much, it looked cartoony.”

Armatures for all the characters were designed for maximum movement, and ranged in complexity from more than two hundred separate parts for the centipede to the basic ball-and-socket earthworm. One animator-friendly feature dreamed up by the armature and mold departments was displacement rings bolted on top of the armatures. “Instead of an animator having to go through a lot of foam latex to get to the armature,” Tom St. Amand explained, “we developed ‘grab rings,’ which were under a sixteenth-of-an-inch of rubber. They made the animating a lot easier.”

Sony Imageworks visual effects supervisor Scott Anderson, CG supervisor Jerome Chen and animation supervisor Harry Walton compare their computer generated shark to the foam prototype sculpted by production art director Bill Boes.

Puppet construction not only facilitated ease of access, but allowed for quick repair or replacement of parts. “On Nightmare, it was very cumbersome to get to Jack,” recalled Bonita DeCarlo. “We had a problem with his upper shoulder area. The animators would get it into position, and then the ball would snap off. We took things like that into consideration this time, giving ourselves as many back doors as possible to get into the puppets to exchange a part. On the centipede, for example, if one of his many parts broke off, we could just roll down the foam, remove that individual section, and replace it with a new part. Also, instead of one casting, with foam solid around an armature, we would cast sections separately.”



Animator Michael Belzer choreographs a musical number performed by the centipede inside the peach. Construction crews – supervised by Bo Henry – built four separate sets to represent the peach pit dwelling area, each designed to evoke the look of a rustic tree house.

To begin plotting out the nuts and bolts of the character armatures, St. Amand used both the measurements of sculpted maquettes – built to finalized height and shape specifications – and his own scale drawings. Originally, it had been planned that his crew – which included Rodney Morgan, Chris Rand, Merrick Cheney and Daniel Campbell – would have to fashion only eight armatures per character. But those optimistic figures changed radically, with the department ultimately producing some 120 armatures. “We ended up with about twenty animators and multiple setups,” said St.

Amand. “That required us to build fifteen armatures for each character – although we only needed seven or eight for the glowworm, since she wasn’t featured as much.”

Normally, final sculptures were not executed until the armatures had been machined. “Having a final armature helped verify that our sculpt would contain the armature,” noted Ranft. “Otherwise, when we went to cast rubber over a joint, we might have corners of the metal sticking through. Sometimes we had to do the sculpt before the armature, which is when we ran into problems. Going back and reworking the armature is tougher than reworking a piece of clay.” Painstakingly precise artistry was required of the sculptors. “Everything had to be perfect, because a two-inch puppet face might be ten feet tall on screen if the shot was a closeup. It was common to spend half a day smoothing a face out and making it look just right.”

After molds were obtained from the sculptures, foam skins were cast, then painted to reflect Lane Smith’s distinctive style. “We called it the ‘Lane Smith treatment,’“ stated DeCarlo. “One of the things Lane does in his paintings to produce textural buildup is to thin down each layer of oil paint with turpentine, drying each layer completely before going on to the next. The production wanted that textural look in the characters – something you don’t usually do with multiple puppets that have to match.” Clothing was made of a cotton-and-lycra fabric that moved with the puppet’s foam skin. Some articles of clothing – such as the grasshopper’s baggy pants – were glued and stitched into sculpted foam to maintain a constant shape throughout the per-frame animation.

The fabrication department remained busy as the normal rigors of production exacted their penalty on the delicate foam of the puppets. Shots were scheduled so that closeups could be reserved for a fresh puppet, with more worked-over puppets used for medium to distant shots. “On average,” DeCarlo said, “we could maybe squeeze a fourth shot out of a particular puppet before we’d have to strip the old foam skin and redo it. In judging how long a puppet would last, we had to take into consideration that some shots were quick and others could go on for four hundred frames. And unlike Nightmare, which had a darker look overall that could hide some flaws, this time the characters were much more in the light; so there was a bit more work required to keep everything looking good on film.”

The entire puppet-making process, from preliminary design to final paint job, was facilitated by constant communication between armature engineers and machinists, sculptors and moldmakers, fabricators and animators. “It was very much a group effort,” St. Amand remarked. “It wasn’t a matter of each of us working in our isolated departments. Each character, by the time it was on the set, may have been handled by twenty or thirty people.”

As puppets were being finalized, supervisor Paul Berry and his team began preparing for the animation task. The dialogue-and-character-intensive show put particular stress on the animators, who were charged with providing the characters with lively interaction. “In Nightmare,” commented veteran Skellington animator Mike Belzer, “there was so much to look at that the animator really just enhanced a scene. In that film, you were drawn to characters – but your eye couldn’t help but be overwhelmed by everything around them. James had beautiful sets, but the environment was minimalist – which worried all of us animators. We realized that the majority of our animation was going to be talking heads atop a peach. What was the audience going to be looking at? Our

animation! It had to be as clean and as great as possible because there was nothing else to grab the viewer's attention."

Mindful of Selick's philosophy that a distinctive walk is the key to revealing personality, the animation team first worked out each character's gait. "We built up a library of walk tests for the different characters," Berry related. "In most cases we went for realistic, fluid movement; but for a character like the centipede, we went for some cartoony action, as well. Unfortunately, there was no time on this show to do prototypes; so sometimes the puppets were created with certain limitations that only became apparent when we started the animation. Multiple puppets for each character were made all at once, so any slight fault was passed on to all of them." In the case of the still-evolving James puppet, the problems were more than slight. "The face for the James puppet was probably the hardest thing we did on this show. By the time we started shooting, the puppet still hadn't been worked out; so for at least six weeks we had to shoot the back of the puppet's head, working on shots that didn't actually feature James' face."

A typical ten-second shot required an average four to five days for prep and three days to animate and shoot. "We first had to feel reasonably comfortable with what the lighting and camera moves were going to be," observed Brian Rosen. "Then the animators would come onto the set with the puppets and do poses – say, every tenth or fifteenth frame. Once we saw a rough video of the key pose run-through, Henry could make suggestions or changes. The animators would then incorporate that information, doing another run-through with poses every fourth frame or so. The next day, Henry might say, 'I'm really happy with that – you're ready to launch.' Then we'd shoot it for real."

The availability of rod removal techniques freed up the animators considerably, allowing them to employ external puppet supports, visible to the camera, when concealed tie-downs, long the standard in stop-motion, proved problematic or inadequate. "Rod removal really helps you stage shots in ways that require less compromise," Pete Kozachik commented. "During Nightmare, digital processing was becoming available, but it was still primarily in the domain of big-budget effects films. As a result, that show had only a few rod removals and maybe a half-dozen bluescreen shots. Now, rod removal is just another buzzword, and everybody knows how to use it."

More than thirty-five rod removals were executed by Buena Vista Visual Effects, utilizing Disney's CAPS – computer animation production system. A fiber-optic link connected the CAPS network in Burbank to a pair of workstations manned by Tim Alexander – one of BVVE's digital artists – stationed at the Skellington facility. From his stations, Alexander could tap into the mother system at BVVE and pull up shots and individual elements, as well as send along Skellington material to Burbank. "Skellington was able to send us sketches or videotape references from their Avid composites for us to work on," said BVVE supervisor Dorne Huebler. "Our editorial staff played a major part in the process because there was so much film to scan into our system. With many shots requiring twelve to fifteen layers, we scanned over 1500 elements in the course of the project. We had two scanners, two film recorders and forty workstations assigned to James."

Although CAPS was a technological godsend, the rod removal process was not push-button automatic. A typical shot required eight to sixteen hours, with more difficult removals taking up to a week or more. "Ideally, we'd take the shot with the rod and a clean plate, developed on the same

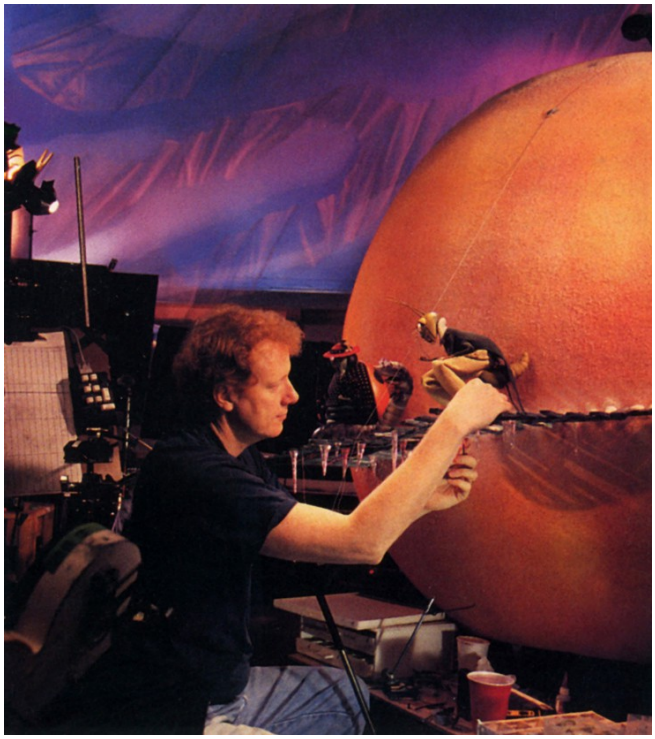
negative," explained Alexander. "With my pen and tablet, I'd do an articulate roto along the rod and up to the edge of a character, creating a matte. Then I'd layer the clean plate behind the rod shot, punch through the hole, and the rod would be gone." If the two plates did not match exactly, the digital artist would carefully paint out the rod frame by frame. "Rod removal is a very underappreciated type of work," suggested Huebler, "because if the job is done well, it's invisible. We've discovered that, usually, the rod is easier to remove than the shadows cast by the rod onto the characters or the set. Time after time, we'd work on a shot, get rid of the rod, and see the shadows moving around – which meant another job to do."

On another interior set, Miss Spider tucks James in for the night.

A motion control camera is readied for a shot of the giant peach flying through teapot-shaped clouds. Buena Vista Visual Effects – tasked with compositing the sequence – enhanced the shots with computer generated columns of steam rising from the teapot spouts.

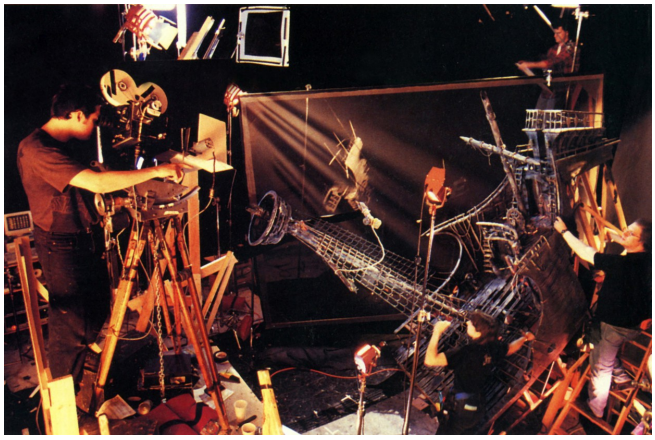
Scenes set in the frozen ice fields of the Arctic were shot on an expansive miniature set, rigged with a flexible base to create the impression of shifting ice floes.

After months of preparation, all of the technical systems, sets, puppets and personnel were in place to film the strange and wondrous tale of *James and the Giant Peach*. The film's opening live-action scenes reveal an old man giving James a bag rustling with mysterious, curly green things. When the boy accidentally drops the bag, the green entities slither through the ground and into the roots of a barren old peach tree that magically yields a giant peach. Seeking escape from his aunts, James tunnels into the peach interior – where a transition to stop-motion is initiated with a cel animated silhouette of the boy transforming into his puppet form.



Owen Klatte animates a scene during the sequence.

Inside the peach, James is introduced to the giant insects. Together, they are launched on an adventure when the centipede chews through the stem that connects fruit to tree, setting the giant peach rolling down the hillside, off a bluff and into the Atlantic. For the beginning of the roll, grips merely pushed the giant, full-scale peach down a ramp, with successive shots in the sequence cutting to Skellington miniatures.



Diving beneath the icy surface, the characters discover a graveyard of sunken ships. A large pirate vessel was constructed, with other smaller ships receding in the distance. Special puppets were also fabricated to suggest floating movements in the watery medium.

As the story progresses, James and the insects open up a hatch in the peach dome and see a magical view of sea and sun. Sony Pictures Imageworks, under effects producer Mickey McGovern and recent Oscar-winning supervisor Scott Anderson, took on the task of creating a computer generated ocean that would fit convincingly within the stop-motion animated world. "Animation-wise, we didn't want this to come off as a computer graphics sequence in a stop-motion film," Anderson explained. "We wanted it to be another stop-motion sequence that just happened to be done on the computer. For a live-action show, we copy what the real world looks like in our CG effects; for this film, we really wanted to capture the nature of stop-motion. The water had to have a hand-constructed and animated feel, yet read as natural to the audience."

Robert Minsk, a Sony software developer, prepared a program based on the physics of the ocean, with each individual wave a hand-animated curve. "Skellington gave us flow charts that tracked how big and fast the swells were from shot to shot, as well as their frequency," Anderson recalled. "With that data we also used Alias to design what we called the 'profile curve,' which was the wave shapes with their motions and frequency of undulations. CG supervisor Jerome Chen and lighting

supervisor and lead animator Louis Cetorelli worked with Henry, Harley Jessup and me to tweak that ocean look. Skellington's Avid edits helped us to make sure we were in sync with what they needed."

To complete the shots, Skellington supplied Sony with thirteen fourteen-foot-square sky and cloud backings, painted with attention to specific time of day and compass direction. "Henry is a stickler for continuity of direction in terms of camera angles," stated Gregg Olsson. "If the camera was on a character in front of a northerly sky view, we had to have the look of that sky direction at that particular time of day."

Art director Bill Boes at work on one of the models used to represent the sunken pirate ship.

The Sony team also cast computer generated sunshine over the entire scene. "The sun was a 3-D rendered element we created for the sky paintings that tied both mediums into the shot," said Anderson. "Our sun had to cast rays and be reflected in our water. Because it was such an art-directed show, we had to cheat reality quite a bit to get the look Henry wanted."

Composited with Sony's digital water and skyscapes was Skellington's animation. For the ocean traveling scenes, the characters were animated atop peaches filmed in front of a bluescreen, a radical departure for artists accustomed to getting it all – characters, environments and even some effects flourishes – in-camera. "The intense blue that was always there took some getting used to," noted Anthony Scott, "but I was so focused on the movements of the puppet that I was able to forget about what was in the background."

Animator Richard Zimmerman positions the centipede for a scene in which the starving insect reels in one of the tasty-looking seagulls conscripted to lift the peach and its crew out of harm's way and fly them to New York. Each of the centipede's twelve arms had to be painstakingly repositioned after each frame of exposure. Digital techniques were employed to eliminate the support rod attached to the in-flight seagull.

The bobbing of the giant peach on the ocean surface was another issue, one that required special motion control rigs for the stage peaches. Kozachik recognized that what was needed were motion bases like those used in simulator rides; however, the prohibitive costs of such rigs left the Skellington team to improvise. The result, dubbed 'full-mo rigs,' were three-point linear actuators mounted to a ring that could handle peach sections weighing as much as six hundred pounds, while allowing for a full range of motion.

"Camera operator Brian Van't Hul and I made a continuous map for the peach bobbing movements over the running time in each sequence," Kozachik said, "so the camera operators on each stage would know how to program their peaches. Sony also had to know exactly what our camera moves

were doing each frame; so for each shot we'd give them floppy discs of our motion control data file. In an ideal world, the computer graphics guy would be able to build the virtual camera to match our ocean views just by plugging in our disc. Sometimes that worked; but if it wasn't perfect, stylistically, I'd ask Sony to tweak it with a little 2-D move."

Sony also handled the creation and compositing of a monster shark that attacks the floating peach. Although in Dahl's book there was an entire school of attacking sharks, Selick opted for one fearsome creature that would look unlike anything that had ever swum in deep blue waters. "I wanted the shark to be different," stated Selick, "so it was designed as a mechanical thing. I happen to love those big Imperial walkers from the second *Star Wars* movie; and that magnificent look always stayed in my mind. Some people asked me why the shark had this mechanical look. Well, why does Donald Duck drive a car? In animation you can do what you want."

The mechanical shark concept was developed in the Skellington art department, with art director Bill Boes producing a foam sculpture. From that sculpture, Sony's Kevin Hudson took the necessary measurements for building the creature in the computer. "We designed the shark with an underlying stop-motion-like armature structure that our animators could work with," Anderson said of the creature, which would be integrated into the CG ocean with digital water trails and wakes. "In the interface, we would click on what we called a 'node' – what could be considered a piece of armature in the stop-motion world. Once clicked on, our animators could move that piece of the armature around."

To help Sony animators bring the shark to life in a style appropriate to the rest of the film, Anderson brought on Harry Walton – another Nightmare alumnus and stop-motion veteran – as animation supervisor. In addition to instructing the digital animators on how to emulate stop-motion's hands-on style, Walton took his own maiden voyage into the world of digital animation. "Harry was a great leader in the education of all our animators," Anderson stated. "They were used to creating very fluid things, because that's the nature of the computer. Harry was able to show them how to emulate stop-motion, making the animation rougher."

Miss Spider's silken webbing is used to catch a flock of sea gulls which then fly the peach and its occupants away from the menacing shark. The webbing was created either practically for stage photography or as a digital element. Likewise, the sea gulls were represented either by CG figures, stop-motion puppets, or a combination of the two. Sony software engineer Dev Mannemela developed special software to create a flock of digital gulls that would behave as mandated by the story. "Our custom version of the flocking algorithm had to provide for the weight of the giant peach, as well as all the spider threads," observed Scott Anderson. "After we created a program that took those things into account, we found that there were too many constraints, resulting in a flock that felt a bit stiff. So we had to go back in and loosen up the flock to make it include a good amount of undulation, while also making it look as if the birds were carrying a heavy object."

When the airborne peach takes a wrong turn, the crew ends up in the Arctic, a vast frozen expanse with a shimmering aurora borealis on the horizon and the remains of old pirate ships, icebound forever. Despite the complexity of the environment, budget restrictions forced the production to produce the sequence largely in-camera. At twenty-four feet wide and thirty feet deep, the Arctic surface was one of the biggest sets in the show. To provide a moving ice floe for the motion control

cameras, Bo Henry designed a flexible base that rippled beneath the sculpted foam simulating the icy surface. “It was basically a plywood piece with a series of little bearings that fit into a slot within the flexible surface and translated movement to the top of the ice floe,” Henry explained. “To work with the stop-motion, a motion control motor drove a winch that took the wave movement to each frame-by-frame position.”

The aurora borealis consisted of three overlapping layers of bridal veil, each lit separately. “Three sets of dimmer lights for each layer were controlled through the motion control systems,” said Kozachik. “Our operator, Ray Gilberti, programmed the overlapping up-and-down fades for the various light layers, creating a really neat effect.”

As the scene continues, the characters dive beneath the icy surface, discovering a graveyard of sunken ships. Bill Boes and storyboard artist Mike Cachuela came up with the visual concept, represented by model ships in the distance and a pirate ship set. “For the main pirate ship there was just a front two-thirds and a back two-thirds of the ship,” noted Gregg Olsson. “We were able to break down all of the shots so that we never needed a full ship.” The deck area was about twelve feet long and four and a half feet wide, and could be broken into some twenty-four individual modules, with duplicates for oft-used sections and a separate set for the crow’s nest ratlines.

In addition to the graveyard set, the underwater sequence required special puppets fabricated to reflect the watery medium. James, for example, had a wired tie and jacket that could be animated with rippling effects and a specially sculpted hair piece to affect the look of floating locks. Animation for the scene was inspired largely by underwater scenes in the Disney classic, *Pinocchio*. “It was an interesting challenge, bringing across that underwater feeling and not losing the impact of an action sequence,” said Mike Belzer, who spent six months on the underwater work. “If you took the animation too literally, it’d be very ‘floaty,’ almost as if the characters were jumping around on the moon. The brilliance of *Pinocchio*’s underwater animation was that it wasn’t all that different from the rest of the film – there were just a few key elements that made the underwater environment believable. So, for James, we might have a character crashing through a ship’s railing, which would be animated at normal speed; but then the pieces of railing would be given a floating action, just to sell the realism.”

Kozachik and his lighting and camera crews used every trick in the book to create moody, in-camera effects for the underwater world. “We used process projectors to double-expose in bubbles,” explained Kozachik. “We had motion controlled ripple glass going over the lens, and scrims that we could run shafts of light down. We also considered using process projectors to double-expose in particulate matter; but Henry wanted it to look like clear, icy water.”

Although in-camera tricks would carry the sequence, most of the shots involved digital rod removals, executed by BVVE. The in-camera ripple glass effects from the stage work significantly complicated the assignment. “It’s really difficult to get rid of rods from a rippling image,” Tim Alexander pointed out. “We either had to touch up those shots or, if the backgrounds were black enough, just blur the rod away.”

Once they reach the main underwater ship set, the characters battle a group of animated pirate skeletons, including a Jack Skellington puppet on loan from Disney. A final luminous touch on the skeletons was a coating of invisible ultraviolet paint that glowed a ghostly white under UV light, a technique used in Nightmare to give the villainous Oogie Boogie and his lair an ominous presence.

With a compass from the pirate ship to guide them, the seagulls lift off with the giant peach in tow, once more bound for New York. Almost all of the sky scenes required constant background movement to create a sense of flight through different sky environments. Initially, all of those shots were to be in-camera composites – but the number of backings that would have been required by such an approach would have swamped the Skellington art department, put more demands on stage space and slowed down each shot with extra rigging and programming requirements. Consequently, the decision was made to film most of the airborne peach shots against bluescreen, freeing up the animators to concentrate on character performance. Bluescreen shooting also allowed for continuity and editorial issues – such as background direction and speed – to be determined after scenes had been cut together.

BVVE was assigned many of the sky composites. "Each sky environment presented its own set of problems to solve," said Huebler. "One sequence, with the giant peach flying through fluffy teapot-shaped clouds, had to have a sense of intense sunlight and heat. Skellington shot the clouds on stage, and we tracked in steam columns rising from the teapot spouts and added layers of wisps flying by. We also pulled mattes from the foreground highlights to heavily diffuse the characters as if they had really been shot this way."

For the night flight, Skellington provided BVVE with painted backgrounds. "We photographed each of the paintings," said Tim Alexander, "dividing them into six different sections that we then tiled together. If

Scenes of the giant peach drifting across a stormy night sky were photographed against a bluescreen and then composited by BVVE into painted backgrounds supplied by the production art department.

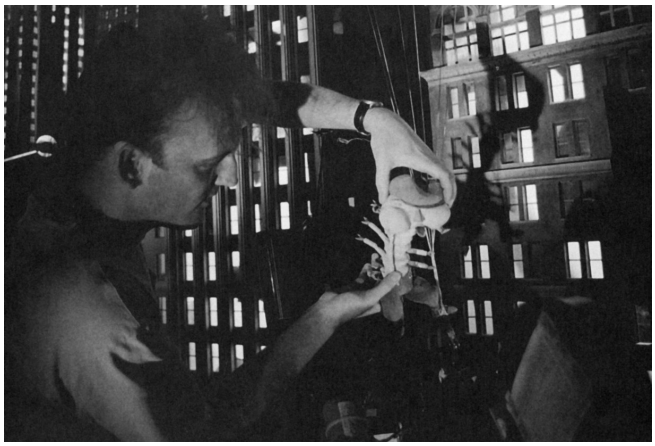
In a surreal dream shot, the camera pulls back from the peach, revealing it as part of a spinning mobile. The fruit is then plucked from the sky by a giant James. The image consisted of star maps and a computer generated mobile,

we had shot each painting as one piece, we'd have had to zoom in and risk losing resolution to move around in it. But in our compositing system, we could line the tiles up into one big image, make invisible seams between tiles, and easily zoom in and pan around the image. We could also isolate some stars to twinkle or multiplane, which helped give a better sense of depth and dimensionality."

modeled and animated by the BVVE team under supervisor Donne Huebler. Shadows and reflections were added to the insects in order to ground them in the scene. Because the action was a combination of stop-motion and live-action perspectives, the scene required a meticulous compositing effort on the part of BVVE.

The journey across the night sky culminates in a dreamy, surreal shot in which James imagines a toy mobile spinning in the heavens. As the scene unfolds, the camera pulls back to a wide view of the rotating, airborne peach, its characters dancing atop the surface. A hand suddenly appears to pluck the peach away, the camera pulling back to reveal a gigantic puppet James. In subsequent shots, the giant boy tosses up the peach, which dissolves into pixie-dust particles. At 1091 frames, the scene was one of the film's longest and a highlight of the fusion of puppet animation and digital artistry.

Requisite star maps were supplied to BVVE by Skellington, along with a two-foot-tall mobile built by art director Kendal Cronkhite for reference. Dangling from the fanciful mobile were old-fashioned tin toy globes representing earth and Saturn, a multicolor striped ball and a gold watch. The computer generated version was a three-dimensional model created from scratch by BVVE CG artist Aaron Campbell. "Some of the objects on the mobile were so specific for color and texture that we had Skellington supply us with flat art we could texture-map over our wire-frame models," Huebler said. "One of the things we were able to do in CG was make all the pieces interactive. If something moved on one side, it created a very fluid movement across the entire mobile."



Paul Berry animates the centipede's jubilant arrival in Manhattan.

The spinning peach shot required three separate sections filmed on the bluescreen stage: a slice off the top upon which the actual characters would be animated; a second, middle section slice; and a bottom third section, with a matte strip in the center to create a blend. "When the rotation stops and James plucks the peach, the peach actually becomes a held-frame piece of art that we had to track into a bluescreen James plate," explained *Alexander*. "We rotoed the puppet's hand to the held art so it looked like James was actually plucking it. Then there is a

Gary Platek of JEX FX created cloud tank elements for the nighttime storm sequence. The image of a charging rhinoceros cloud was achieved by shooting an articulated rhino puppet in water against a greenscreen. White paint pumped into the puppet was diffused through the rhino's fabric covering to produce the cloudy effect. BVVE

CG dissolve of the peach, done with a particle breakup program."

composited the shots, which were enhanced with animated lightning and other sweetening elements.

The airborne peach eventually floats into sight of Manhattan, an event greeted with some delirium by the populace below. But there is one last hurdle for James and his friends: a furious thunderstorm through which bursts a charging cloud rhinoceros, the personal Doppelgänger that has been haunting young James throughout his childhood. The effect utilized cloud tank clouds from JEX FX – specialists in cloud tank photography and laser effects – a rhino puppet filmed greenscreen in the cloud tank, effects animation lightning elements, and other touches to blend the composite shots.

JEX FX produced both cloud elements and shots of the rhino puppet, built by Kelly Lepkowsky. With his crew, company president Gary Platek – who had been stirring up cloud tank magic since his work on *Raiders of the Lost Ark* – created the cloud elements in a clear glass tank that was seven feet square and four feet deep. Elevated three to four feet off the ground so that it could be bottom-lit and accessible to the locked-off camera, the tank was filled with water from two adjacent holding tanks and was equipped with hoses connected to two one-gallon paint pots.

For a typical cloud effect, Platek filled the tank halfway with salt water, covered it with a sheet of plastic, then filled the remaining half with fresh water. "When I pull out the plastic sheet, it leaves two distinct segments that will sit there until I stir them," Platek explained. "The salt water creates a foundation. If I injected paint into fresh water only, it would go everywhere. With this approach, I can shoot a paint mixture into the fresh water, but it won't go into the salt water level. I can then control the types of clouds I create with a probe – a brass tubing wand with holes in it that I inject the paint through."

Extensive design and testing was required of the foot-long rhino puppet which was made up of an aluminum skeleton and a vacuform body covered with black cloth. For maximum control, Lepkowsky had designed the puppet with a variably controlled motor so that its galloping legs could go forward and backward. "We had an eight-foot track at a right angle above the tank," said Platek, "with an electronic drive shaft holding the puppet underwater and driving the legs." For the cloud effect, white paint injected into tubes concealed in the horn, jaw line, upper shoulder area and legs was diffused through the fabric covering the puppet. "The white paint starts to spew, then goes to black. The concept was to capture this smokin' cloud creature that's starting to disintegrate, going into flame-out like a kamikaze pilot."

The rhino cloud shoot was slow going. "Each morning we'd check dailies and set up, start shooting in the afternoon, prep and fill the tank, adjust the lights and then insert paint," Platek said. "After a take, which might take a minute, we'd have to dump the tank, clean it out and start all over again. Over the course of a work day we'd get two takes, maybe three if we were lucky." Ultimately, JEX FX completed fourteen cloud rhino shots and additional cloud tank effects in a four-month shooting period.

To facilitate the pulling of mattes at BVVE, many rhino elements were photographed greenscreen. "The problem with using bluescreen underwater is that it's difficult to get a separation," Huebler commented, "but green redirects the natural blue wavelengths in the water as green. Jon Erland's

company, Composite Components, supplied the greenscreen, along with sleevings to cover the rods that came down from the drive shaft into the puppet."

James overcomes his fears, and the giant peach descends into the Big Apple through an opening in the storm clouds. "Seeing New York for the first time is the culmination of this kid's dream," said Kozachik, "so we wanted it to appear like a jewel. For the scene, a bottom-lit tabletop miniature transitioned to a live-action New York forced-perspective set.

As James transforms from a puppet back into a real live boy, his insect friends cavort within the live environment as digitally composited stop-motion elements. The finale, in which the evil aunts who have come looking for James find themselves ensnared in Miss Spider's webbing, required meticulous stop-motion. "When we had animation combined with live-action," Paul Berry noted, "we had to make sure that the puppet's eye-lines matched exactly the eye-lines of the live actors. On stage we had video monitors of the live-action that we could line our animation up to, tracking our characters to the live actors frame by frame."

BVVE supplied interactive touches in the final digital composite to better marry the live-action and bluescreen puppet characters. "With digital compositing, we pretty much took it for granted that matte lines were not going to be a problem," said Huebler, "so we could concentrate on lighting and color differences between foreground elements and the background plate, perfecting tracking and adding shadows to make sure it all looked like a seamless piece of photography."

The finale illustrated brilliantly *James and the Giant Peach*'s overall success in combining stop-motion animation with the palette of the digital realm. Both the stop-motion animators and the digital artists had gone into the production unsure that such a seamless blending of techniques was possible. "At the beginning," Dorne Huebler recalled, "there was a fear that any shot done digitally would come back not looking right. But trust grew over the course of production. One of the challenges of the collaboration was helping to define this unique universe by making sure all our scenes fit right in. Putting physical puppets into a digital environment really brought them alive and created the feeling that they were in a bigger universe, and not just on a stage."

"In James, all of these technologies came together to create a totally new universe," added Scott Anderson. "It was very organic, unlike anything ever done before. Art direction, lighting, animation and effects were all used to take you on a journey into Henry Selick's vision of James' world."

At the end of production, Selick himself entered into a new phase of his personal stop-motion journey, inking a deal with Disney's Miramax division to head up a new stop-motion animation unit named 'Twitching Image.' Although the San Francisco facility would house an as-yet undetermined animation project, the Skellington chapter itself had come to a close. "For everybody who worked here through Nightmare and James," Pete Kozachik commented, "it was a major chunk out of our lives. There's a good sense of closure, though. We got through two shows, and we set high-water marks on both of them."

For Henry Selick, it was enough to know that a place in the animation pantheon would still be held for the stop-motion medium. *James and the Giant Peach* had illustrated that digital breakthroughs could enhance stop-motion, not lead to its extinction. Walt Disney himself had an intimation of this unfolding new world of animation wonders back in 1940, the year *Fantasia* was released. In that film's 'Ave Maria' finale, a rare multiplane camera shot had created the illusion of a camera tracking

in, without a cut, through the cathedral-like arches of an animated forest. Through that crack, Disney's wondering eye had seen a bright vision for the art of animation: "What I see way off there is too nebulous to describe, but it looks big and glittering."

James and the Giant Peach photographs copyright ©1996 by The Walt Disney Company. All rights reserved. Skellington Productions still photography by Eric Swenson, Bo Henry and Kelvin Jones. Additional photography courtesy of Sony Pictures Imageworks and Buena Vista Visual Effects. Special thanks to Howard Green and Mickey McGovern.

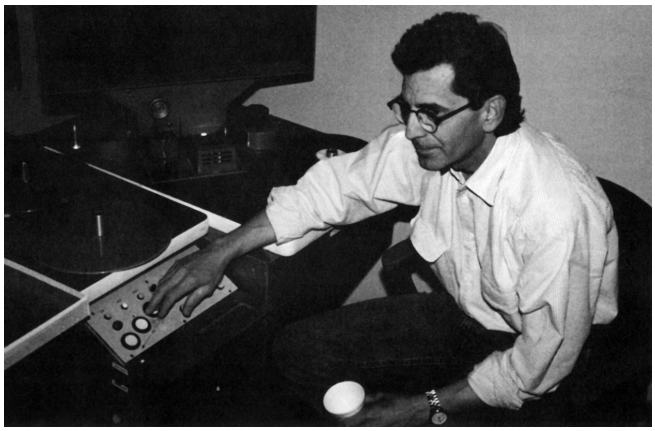
MICHAEL FINK
FROM FINE ARTS TO FILMMAKING

article by Estelle Shay

Nearly two decades have passed since visual effects supervisor Michael Fink's career took a detour from fine arts into filmmaking. In 1977, Fink was a starving artist looking for temporary employment to support his studio work, when former roommate and fellow Cal Arts graduate Stuart Ziff offered him a job on *The China Syndrome*. Caught up in the special effects boom that followed, Fink found that he had discovered, quite by accident, the ideal medium for melding his fascination with technology and his artistic skills. Twenty years later, he is still devoted to the pursuit.

"Looking back now," Fink reflected, "it seems as if I was headed pell-mell into visual effects for probably ten years before I actually did it." Fink's exposure to movies began at a tender age with his father's peripheral involvement in the film industry. "My father was an inventor and entrepreneur who, for a short time, had a company that produced and sold novelty items based on popular film characters of his time. In those days, there weren't any agents or lawyers standing between the stars and the people they did business with; so I can remember the thrill of being six years old and going to movie sets with him."

Raised in the San Fernando Valley, Fink was not yet a teenager when he began dabbling in amateur visual effects. "I was technically minded, but also artistically inclined. When I was eight years old, I discovered a pre-*World War II* twin lens reflex camera that my father had found. I was totally intrigued by it, and would open it up and examine all the parts. At ten, I began taking pictures with it. I had this plastic model of a rocket to the moon that I would photograph in a darkened hallway of our house. I put cotton coming out the back of it, then backlit it with a flashlight and took interminably long exposures on very slow black-and-white film." Continuing to explore photography and effects of all sorts, Fink let his curiosity lead him into riskier pursuits as a teenager. "My friends and I began experimenting with pyrotechnics. Our house had an attic where I used to store all sorts of chemicals. We would mix them and make our own rocket fuel, black powder, thermite, depth charges; and fire the rockets and bazookas, or ignite the charges that we built. It was very dangerous stuff, actually, and a couple of us nearly lost body parts."



In college, Fink set aside his creative pursuits to earn a degree in business, then worked as an investment banker following a two-year stint in the army. "I was twenty-six and making a lot of money – but the work just wasn't for me. So I took a leave of absence to attend art school in *San Francisco* for two years, then completed my masters degree at Cal Arts. I was rooming with four other artists in Sylmar and looking for a way to support my art career when Stuart Ziff – who later went on to earn a technical

achievement award for his work with Phil Tippett on go-motion – offered me the job on *The China Syndrome*."

Effects veteran Michael Fink brings twenty years of experience to his new posting as senior visual effects supervisor at Warner Digital Studios.

Charged with designing a computer system that would simulate a nuclear power plant control room, Ziff, Fink and Richard Hollander – another Cal Arts graduate and mutual friend – set about creating the first ever computer-controlled movie set. "The producers were worried that if the set was not totally accurate, they would get ripped apart in the press by the nuclear regulatory people," Fink recalled. "So Richard, who has a degree in computer science, literally built a computer from scratch. You couldn't go to the store and buy one in those days – you actually had to build it, memory boards and all. Stuart designed the interface stuff; then I put it all together and figured out a wiring scheme so that the equipment would work interactively with the actors. We labored twenty hours a day for six weeks to build the set, completing it just five hours before the company was scheduled to start shooting. But the cast and crew were great and the picture was on schedule and within budget. It was an absolutely perfect first experience in the movie business – a wonderfully collaborative effort."

Once *The China Syndrome* wrapped, Fink went to work for Universal Hartland – the visual effects facility built by Universal Studios in the aftermath of *Star Wars*. "The entire crew that had worked on *Close Encounters of the Third Kind* was there, and I joined a team that included people like Peter Anderson, Alex Funke, Hoyt Yeatman, Scott Squires, David Jones and Glenn Campbell. At Universal Hartland, I developed new techniques for shooting miniatures in front of a bluescreen. I followed our tests through opticals with Bobby Hall and got my first real immersion in film opticals. Colin Cantwell was also there during that time, and he developed the first 3-D computer graphic storyboards I had ever seen. It was an exciting time."

Fink – who earned an Oscar nomination as visual effects supervisor for Batman Returns – checks camera line-up during miniature shooting on the Penguin's abandoned zoo lair set.

Although his tenure at Universal Hartland was short-lived, Fink had become enamored with the business of creating images on film. "One of the things I discovered about the movie industry was that it enabled me to work collaboratively with people. Being a visual artist is not a communal profession; and I liked being in a community. So I began to do movies more and more, and my art less and less."

In 1979, after building miniatures for the special edition of *Close Encounters of the Third Kind*, Fink was approached by industry trailblazer Douglas Trumbull. "I was still doing *Close Encounters* reshoots when Doug walked in one day, and said, 'How about coming to work for me on *Star Trek: The Motion Picture*?'"Fink eagerly joined the effects crew, along with many of his coworkers from the now defunct Universal Hartland. "Doug got the show in April, and it had to be in theaters by December; so we worked around the clock at his facility in Marina del Rey – which eventually became Boss Film."

Following several freelance assignments that included miniature work on *One From the Heart* and creating technical props for *Blade Runner*, Fink earned his first credit as visual effects supervisor on the 1982 film WarGames. “That was also my first experience producing digital images for film,” observed Fink, who supervised the design and installation of the first real-time 24-frame-per-second computer system for displaying data and simple graphics simultaneously on 120 video monitors. “We had to create these maps to project up onto the process screens. It was all done using animated 2-D computer graphics, beautifully designed by Colin Cantwell. We built three film recorders from scratch and shot approximately 50,000 feet of negative, which was turned into 120,000 feet of process plates.”

During the next ten years, Fink continued as a freelance visual effects supervisor, keeping pace with the digital revolution and its application to film. On The Adventures of *Buckaroo Banzai*, he implemented the first real-time color computer graphics system used on a movie set. For Project X – which featured chimpanzees operating flight simulators – Fink linked up with General Electric’s software development department in Florida to design and execute 3-D computer graphics flight simulation footage. As effects supervisor on Tim Burton’s *Batman Returns*, he worked with Boss and Video Image to create digital bats and penguins that would represent a benchmark in computer generated effects – the first film images of real animals rendered wholly in 3-D computer graphics. His contributions to the production earned him an Academy Award nomination.

In 1993, Fink made a brief foray into directing. “It was the first round of CAA Coke commercials,” Fink related, “and Ken Stewart – who was the producer – came to me with this idea for a polar bear spot and an offer to direct. I thought the time was right for a CG approach; so we took it over to Rhythm & Hues. It was interesting, because Ken and I really believed in the project – but it seemed as if the agency and the client had relegated it to fairly low status. Then shortly after we got underway, they previewed the commercial at a bottler’s convention – just a temp version we had pieced together quickly on video – and it was a huge hit. Everybody wanted it.”

One of the achievements Fink is most proud of is his contribution as visual effects supervisor on the 1994 epic Braveheart. Working for RGA/LA at the time, he was on hand during filming to assist director Mel Gibson in determining the extent to which visual effects could enhance the complex battle scenes. “It was the first time since *The China Syndrome* that I had been on a show where I really felt as if I was a part of the whole creative process,” Fink reflected. “Plus, it was a good opportunity to use the tools that were now available to us. Without digital technology, there would have been a couple of matte paintings in the movie, and maybe some splits along the lines of *Spartacus* to make it look as if a lot of people were on film. With it, we could overlap people and have them running through the frame with moving cameras.”

In September 1995, Fink joined Warner Bros Imaging Technology – since renamed Warner Digital Studios – as senior visual effects supervisor. Responsible for guiding the new company’s visual effects division, Fink has goals that are twofold. “One is to develop technologies and tools for filmmakers that are flexible and powerful enough to give them exactly what they want. And – since we are seeing more and more scripts where characters are being created digitally in ways that not only augment, but actually drive the story – the other is to develop really strong animation skills. We have some incredible animators at Warner Animation and Warner Feature Animation who will

work with us in that regard." With plans to relocate to a larger site close to the Warner Brothers main lot, Fink and newly recruited production supervisor Ellen Somers expect to expand the studio three to four times beyond its current size. "Our first order of business will be to put together a strong software development team so that we can begin developing tools that our own animators and compositors can use effectively."

After years of freelancing, Fink is excited to be part of a more lasting endeavor. "Having worked out of nearly every effects studio out there, I felt that I knew where a facility could be strong and where it could avoid mistakes; and I really wanted to try doing that. When you freelance, you work very hard to get a picture done, you bring the people together, you build something – but when the picture is done, it all goes away. After a while, you start to feel that maybe you could use your juices to create something that stays around. I've been given the opportunity to do that here."